THE

Practical Teacher

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'*Knowledge is proud that he has learned so much,*
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

BY ALFRED CARPENTER, M.D., M.R.C.P. (LOND.),
Chairman of the Council of the Sanitary Institute.

CLOSETS—(*continued*).

There are very numerous varieties of w.c.'s. The best kinds may be seen in action at the Parkes Museum in Margaret Street, London. The simpler the construction the better. The discharge of water when the handle is raised, after the closet has been used, should be immediate, rapid, and complete, not taking more than five seconds for the whole discharge, so as to flush away the soil and leave the w.c. perfectly clean. There should be not less than two gallons of water for each flushing. The soil should be carried off directly into the sewer; there should be no chance of its retention in the neighbourhood of the closet by any faulty construction of the soil-pipe or house-drain. The Bramah valve closet is the oldest form now in use, but a w.c. is not a perfectly recent introduction, for Evelyn, in his Diary, written about 1690, mentions a w.c. as existing at Beddington House, close to the present sewage farm of the Croydon Corporation, which excited his admiration as an ingenious piece of mechanism.

The conditions which make a good w.c. are that the water seal should stand well up in the basin, the water not liable to syphonage; that the closet should be well-lighted at all times, so that the water in the basin can be seen. The basin should be flushed thoroughly clean by each discharge, by which every part of the basin and trap should be left free from foulness. If also it could be rendered available for slop discharge, so much the better. The lid attached to a closet seat is a mistake; it is wrong to shut it down, so as to cover in any smell which may be there. There should be free ventilation all around, and the w.c. which shows all its parts is so much better than one shut up in mahogany fittings, and boxed up so that foulness may be hidden away instead of being altogether prevented, and the surroundings dusted out by the chamber-maid regularly every day. It is necessary that great care be taken to ensure an adequate ventilation in the soil-pipe, so that the trap may not be destroyed by syphonage. If this protection cannot be afforded by any reason connected with situation, it is better to completely change the position of the closet so as to allow of a ventilating pipe being carried into the open air, so as to protect the trap; otherwise a pail of water, suddenly discharged, may unseal the trap and put the w.c. in direct communication with the soil-pipe. The soil-pipe should itself be ventilated by being continued straight upwards to the top of the house with a bore as large as the soil-pipe itself. It should be covered at the top by a grating or cowl, so as to prevent the stoppage of the upward current, which a bird's nest or other kind of cork might produce.

The provision as to soil-pipe ventilation must on no account be omitted. The top of this ventilator should be decidedly above the level of the windows. It should not be near to the level of a chimney or in such a situation as that its unseen smoke may find its way into the house before the gaseous material can have been oxidised and its virulence destroyed. A movement of a few yards in the open air will certainly effect this object, though it is possible that there may be a disagreeable smell. No enthetic disease will be propagated, provided the gaseous matter has been thoroughly diluted with pure air in the upper regions of the atmosphere. The minute germs of particulate matter upon which the promulgation of disease depends will be annihilated by admixture, and the change which friction will establish in its passage through the atoms of gas which make up the atmosphere. I introduced the proposal of soil-pipe ventilation at a meeting of the Social Science Association some fifteen years ago; it was decidedly sat upon by some of the *savans* then present, but it is now universally regarded as a necessity of the water-carriage system of sewerage. After it was recognised by some of our local authorities it was ignored by the race of plumbers, and in my own town it was the custom to put in a dummy ventilator, so as to comply with the bye-law; they were thought to be useless, and "Carpenter's fads" existed in a great number of instances in Croydon, until an epidemic of fever exposed the fraud to the unfortunate householder and the local authority.

In some instances it may be necessary to place a disconnecting trap between the house drain and the public sewer. These traps may be put down by in-

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dividual householders for their protection against the evils which may arise from defective sewers, but they ought not to be required to be inserted by a local authority. A main sewer should never be defective, and for a local authority to allow it to remain so, and to call upon householders to put in a disconnecting trap is insanitary and not good form. If sewers were not defective there would be no necessity for disconnecting traps. The ventilation of the soil-pipe, and the entire separating of all other connections with the sewer would be amply sufficient for the protection of the householder without adding another danger to the system, for the greater the number of traps, the greater the annual expense and the greater the chance of foreign matter getting into the house drains.

A disconnecting trap requires to be protected by its own special ventilation, and is another departure from that simplicity which is always the safest and is an interference with one of the canons of sanitary science. Still, if a main sewer is known to be defective, the householder will be wise to submit to the infliction; of the two evils, it is always better to choose the least.

Earth Closets.—These can never come into common use in large towns, unless water is very scarce. The quantity used by a w.c. system is but a small addition to the total quantity required under ordinary conditions. There must be sewers for the conveyance of slop and waste water out of the place, and an addition of four or six gallons per head per day to the total quantity to be supplied by a waterworks is not very large. If there are sewers, there must be an outfall, and there is, therefore, already provided a silent highway for the conveyance of excreta to the farm, which is costless and out of sight. This is much cheaper than bringing the farm into the town and mixing it with the manure there, and then having to convey it back again to the country. Human excreta do not materially add to the offensive nature of the sewage, for, under any circumstances, the urine finds its way into the sewers; the washing of dishes and laundries, and swillings from slaughter-houses, the waste from baths, and other places of similar kind, will produce a sewage which chemically does not differ materially from that provided by a water-closetted town. But then sewers must have an abundant water-supply, which must be continuous. If a sewer is likely to be dry at frequent intervals—that is, if there is not a constant stream of sewage in it—it becomes a source of danger to the inhabitants, and ought not to be permitted. It follows, therefore, that whilst w.c.'s are the best house arrangements for town populations, they are seldom fitted for villages and sparsely-peopled districts. In these cases the earth closet becomes the necessary appendage to the home. An earth closet requires simplicity and strength of construction; there should not be any intricate mechanism by which it may be liable to get out of order, and it should be self-acting. The earth, or other deodorising material, should thoroughly cover and absorb all offensive matter as soon as the seat is left by the user. The magazine for storage of earth should have considerable capacity, so that it may not be rapidly emptied, and the pan under the seat for the reception of the excreta and its subsequent dose of earth should be almost indestructible and easily removed, at frequent and regular intervals. The action of ordinary garden mould in removing smell is well known to the country housewife. It rapidly removes the noisomeness of even cats' excreta—a shovelful of earth is fetched, and the most offensive excreta rapidly deodorised by it. There should be about one and a half pounds of dried earth for each discharge. The closet in ordinary use should be out of doors, or so placed on an outside wall that the gardener or other person employed should be able to take away the pan without having to enter the house for the purpose. This change should always be made in the early morning before the family are moving; the person changing the pan or pail should be able to see that the closet is not occupied at the moment of removal. Any one occupying a house having a quarter of an acre of garden is unwise to allow of the removal of excreta by any other means, as the gardener can always use it with great advantage, whilst, with very little trouble, he will be able to supply sufficient earth to keep the hopper of the closet properly charged. There is no difficulty if there be a garden at hand. The difficulty comes into play when the cottages of the poor are to be considered. They cannot provide earth, or always use up the contents of the pans; the landlord or the local authority must make proper arrangements for their periodical removal. There is usually some shrewd gardener or farmer in every neighbourhood who will find it to his interest to do this; and if he is not to be found, the village squire or the local authority must make arrangements for the purpose. Two pails are necessary for every closet, one to be in use, the other ready for placing when that in use is removed. There must be a store in which the unused pails may be stored. They should be properly cleansed after use and before they are put in the store-house. This should be effected by thoroughly washing them in a solution of carbolic acid or some other equally effectual disinfectant, and allowing them to dry before storing them away. The material of which the pails are constructed must not be capable of being injuriously acted upon by the disinfectant. The plan entails some annual expense, but there is not the great outlay which a sewerage system demands; there is no first charge, therefore, for capital expended, and this latter cannot be lost, as is now too often the case; because the plan of sewerage adopted has been carried out for the benefit of the engineer and not of the town. The material should be dried earth of a loamy character: sand will not do, and chalk or earth containing much calcareous or silicious matter is inadmissible. An argillaceous soil is advantageous if it is friable. Pitch pine sawdust is a very cleanly substitute, and charcoal is effectual, but it is too expensive for cottage use.

Some closets are made in which the pails have double chambers to separate the liquids from the solids. They are not so satisfactory as a pail which is supplied with a sufficient quantity of earth or sawdust that the liquid is soaked up by it. The exchange must be more or less frequent according to the number of occupants in the house. A change every day is better than one made too seldom, and it should never be left longer than four days without the exchange being made. The contents of the pails should be used up at once in agricultural or gardening operations, and not be stored, as they lose their value by keeping, and may be a source of danger if collected in bulk.

Earth closets are admirably fitted for use in sick-rooms, and are the necessary adjuncts to the hospital wards.

It is a mistake to endeavour to make any concentrated manure, such as so-called 'Poudrette,' out of the contents of earth closet pails. The sooner the excreta is mixed with a larger supply of earth and exposed to the action of vegetation the safer it is for the community and the better for the vegetable world. No germ of enthetic character can escape the decomposing action of vegetable cell-life, but the resting spores of a fever cacozyme may be wrapped up and kept for any time when preserved as poudrette, ready to spring into deadly action if opportunity should arise for developing its dangerous energy, should it find a suitable soil to increase and multiply in. The pail system finds favour in some great towns, such as Manchester, Glasgow, Leeds, and Rochdale; but it is a makeshift system: there is always a danger in the effort which a local authority may make to cut down expense by increasing receipts. The manufacture of artificial manures should only come into play as secondary actions, and never be made the primary object of a sanitary authority. When that is the case, it may happen that health is sacrificed to £ s. d., and the *raison d'être* of the authority lost sight of in the effort to save the present rate.

The plan adopted at Manchester and Glasgow is probably as free from objection as any such arrangements can be made; but the substitution of w.c's. for pails could not fail to be advantageous to the dwellers in those great towns.

Middens, privies, and cesspools ought not to be permitted to exist on any pretence: they are unnecessary, except for the purpose of providing work for the doctor and raising a death-rate.

The Scavenging of Towns.—This matter is intimately associated with the removal of refuse, and may be considered here. No town can be kept in a good sanitary state which is not regularly seweraged, and the ultimate disposal of city refuse is intimately associated with this part of the subject. If there is any plan of pail collection in a crowded locality, it must be also considered in connection with the ultimate disposal of the refuse.

The subject resolves itself into several heads: The nature of the sewerage arrangements; the disposal of the rainfall; the surface cleansing, and the ultimate disposal of collected rubbish as well as the collection of the house refuse—that is, the contents of the dust-bins—and the thousand and one articles which find a temporary resting-place in the receptacles for dust. If there is a water-closet system in general use, human excreta do not come into the calculation in the scavenging account; but in Manchester and Glasgow there is a large admixture of pail contents which have to be dealt with by the local authority, it adds materially to the difficulty of the case. There is, therefore, the removal of night soil to be considered. I must refer those interested in this question to the plans pursued in Manchester and Glasgow, at which places the most extensive works are in operation for dealing with the excreta.

The scavenging of private courts and yards must be provided for, and their sweepings carefully removed. Whilst street-sweeping is only of secondary importance to excreta removal, a city which allows its streets to be filthy, which allows heaps of refuse swept up to be scattered again before the heaps are removed, cannot be healthy.

(To be continued.)

The New Class-Subject, 'Elementary Science.'

(What to teach, and how to teach it.)

BY RICHARD BALCHIN.

To teach elementary chemistry to a class of little boys, so that the youngsters shall, at the end of the school year, be in possession of the main facts touched upon, it is, as many teachers know, absolutely necessary to be continually recapitulating. I do not mean that the *same words* should be continually repeated, for it is not my purpose to impart *words*, but rather to bring about the mental digestion of thoughts and ideas. It is thus that the reader of these notes will find the same experiment performed over and over again; each time, however, with a view of eliciting a new fact. The old experiment is repeated, and regarded from a different point of view; and at the same time an opportunity presents itself of referring to a previous lesson. For instance, the experiment showing the decomposition of the red oxide of mercury is given in Lesson II. simply to prove that this substance is a compound. It is repeated in Lesson IV. to show the precise composition of the oxide. We meet with it again in Lesson VII. to illustrate analysis and the action of heat as a chemical agent. In Lesson XX. we discuss the chief compounds of oxygen, and the experiment is repeated. I greatly prefer to fix a truth in the minds of boys in this way, than to adopt the common method of stating the fact in a neat sentence, and getting the class to repeat the words simultaneously, sometimes by the half-hour together.

LESSON VII.—ANALYSIS AND SYNTHESIS.

Elementary bodies—about sixty-six. Many hundreds of compounds of these. Some compounds contain two elements, such as water, oxide of iron, ammonia, oxide of mercury; these are like words of two letters. Write a word of two letters, such as 'on'; then by the side of it the formula of a binary compound, such as water, H_2O. Compare. Some compounds contain three elements, such as chalk; others more than three. We can separate compounds into their elements. Such an operation is called 'analysis' (Greek, *analusis*—a loosening), and means a breaking up into parts. Instance, analysis of sentences. Note at present three methods of analysis:—1st, by heat; 2nd, by electricity; 3rd, by displacement.

1st. By heat. Analyse the red oxide of mercury, note also the making of lime. Expel the oxygen from chlorate of potash.

2nd. By electricity. Describe or perform the electrical analysis of water.

3rd. By displacement. Obtain hydrogen from sulphuric acid and zinc. The metal displaces—*i.e.*, throws out of its place the hydrogen of the acid. Sodium displaces the hydrogen of water by combining with the oxygen.

LESSON VIII.—SYNTHESIS.

Compounds may be broken up into their elements, as we have seen; this is analysis. But elements combine to form compounds; this is synthesis. Burn some charcoal (carbon) in a jar of oxygen. The element carbon combines with the element oxygen to form a

compound body—carbon dioxide. Boil some mercury under a stream of oxygen—a compound—the oxide of mercury is formed. The oxygen of water combines with iron to form rust—the oxide of iron. 'Synthesis' (from Greek, *sun, thesis*—a placing together), means the formation or building up of compounds. Some elements more readily combine with each other than others. For instance: Place some iron nails in water. The oxygen rather than the hydrogen of the water combines with the iron. Elements which readily combine are said to have an affinity for each other. Oxygen has a great affinity for most of the other elements. Dissolve a small piece of phosphorus in bisulphide of carbon, CS_2. Pour some of the solution on a sheet of paper. The CS_2 quickly evaporates, and the finely divided phosphorus will take fire spontaneously—*i.e.*, readily unites with the oxygen of the air.

LESSON IX.—SYNTHESIS.

Elements combine to form compounds. This is synthesis. Compounds also combine to form other compounds; this is another form of synthesis. For instance, lime is a compound; it is an oxide of calcium, CaO. Limewater is this substance in solution. Carbon dioxide, CO_2, is another compound. We may combine these two. Carbon dioxide is formed —(1) by the combustion of substances containing carbon; (2) by volcanoes; (3) by animal respiration, and by fungus plants. A portion of our exhaled air is CO_2. Breathe through a glass tube into some limewater. A synthesis takes place. The CO_2 of the breath combines with the CaO of the solution, and forms carbonate of lime, $CaCO_3$. Write this formula upon the blackboard, and note the following series of facts: (1) Some elements have combined to form a compound; what is an *element*? what is a *compound*? (2) How many elementary bodies are there in this compound? Three; viz.—calcium, carbon, and oxygen. (3) Properties of each. (4) Affinity of the O for the Ca; what this means. (5) Recapitulate facts concerning the compound CO_2.

LESSON X.—SYNTHESIS—*continued.*

Recapitulate previous examples of synthesis. Repeat the experiment with ammonia and hydrochloric acid, as described in Lesson II., *i.e.*, moisten the inside of one tumbler with strong solution of ammonia, and place a card over it; moisten the inside of another tumbler with hydrochloric acid, and invert it upon the card on the first tumbler. Both glasses are now filled respectively with the gases of ammonia and hydrochloric acid. Gently draw the card from between the glasses; the gases combine and form white fumes of chloride of ammonia.

$$NH_3 + HCl = NH_4Cl.$$

Briefly describe the various elementary bodies forming these compounds, viz., hydrogen, nitrogen, and chlorine. Also briefly describe the nature of ammonia. Its presence in the air is due, 1st, to the decay of animal and vegetable substances; 2nd, to the decomposition of the aqueous vapour in the atmosphere, through the agency of electrical discharges, *i.e.*, lightning. Thus:—

$$(4N + O) + H_2O = NH_3 + NO_2.$$

That is to say, the electrical analysis of water (H_2O) in the atmosphere ($4N + O$) results in the formation of ammonia (NH_3) and ozone (NO_2). Having performed the experiment showing the synthesis of the gases of ammonia and hydrochloric acid, explain the same by an equation thus:—

$$NH_3 + HCl = NH_4Cl.$$

The resulting compound is chloride of ammonia or sal-ammoniac (*i.e.*, ammoniacal salt). The white fumes are really countless little crystals of the salt. These may be viewed under a microscope.

LESSON XI.—THE CHEMISTRY OF THE AIR.

Repeat the experiment described in Lesson VIII., *i.e.*, dissolve some phosphorus in bisulphide of carbon (CS_2). Moisten a piece of filter paper with the solution. The CS_2 quickly evaporates, and the finely divided phosphorus at once begins to unite rapidly with the oxygen of the air; *i.e.*, there is spontaneous combustion. White fumes of phosphoric anhydride (P_2O_5) are formed. In contact with water, this anhydride speedily dissolves and forms its acid, thus:—

$$P_2O_5 + 3H_2O = 2H_3PO_4.$$

This experiment proves the presence of oxygen in the atmosphere.

Perform the common experiment of burning a piece of phosphorus in a bell jar over water, as described in the reading book. The whole of the oxygen of the air is taken up by the phosphorus, giving rise to white fumes of phosphoric anhydride, which, falling into the water, turns it acid by the formation of phosphoric acid. The gas remaining in the jar is nitrogen. The water rises to about one-fifth of the height of the jar to replace the oxygen.

(Note.—In performing this experiment it will frequently happen that the water rises considerably higher than one-fifth. On one occasion at the school, it rose and half filled the jar; and the explanation gave rise to a rather animated discussion between me and the boys. If a rather large piece of phosphorus is used, the great heat generated, expands the air in the jar, and there is an outrush of a portion of it; the remaining air being hot and rare. Afterwards, when the phosphorus has burnt out, the jar cools, the enclosed air condenses, and so occupies a smaller space. This accounts for a much larger volume of water rising in the jar than would be the case if it were simply a question of occupying the space previously filled by the oxygen.)

The facts concerning the presence in the air of carbon dioxide, of aqueous vapour, of ozone, and of ammonia may here be recapitulated.

LESSONS XII. to XV.

These lessons deal with the elementary bodies, oxygen and hydrogen. I need not, however, give notes, for all the necessary facts and experiments are given with sufficient fulness in the Science Readers for Standards IV. and V.

(To be continued.)

Article 106 (*b*).

Merit Grant in Infant Schools.

BY MRS. MORTIMER,

Lecturer on Kinder-garten at the Home and Colonial Training College, London.

Section II.—Phenomena of Nature.

LESSON—THE SPRING.

Now, children, I want you to think about the different kinds of weather we have. What kind of weather is it to-day? It is wet weather. And do you remember what it was like yesterday? It was very bright and sunny. Was it hot? Not all day, it was very pleasant when the sun was shining. Yes, but there is one part of the year when it is very hot. Do you know what we call that time? The summer-time. Then there is another part of the year when it is very cold. What do we call that? The winter. That is right; the hot time we call summer, and the cold time, winter. Besides these we have two other parts of the year called Spring and Autumn. How many parts of the year have I told you? Four parts. Well, there is one name for these. We call the four parts, 'the Seasons.' Tell me the names of the seasons? Which is the hottest season? Which is the coldest? Spring comes between the winter and summer; that is, it comes after the coldest time and before the hottest time. Autumn comes after the summer or hottest time. Can you tell me what comes after the autumn? Yes, the winter or coldest time. So you see the four seasons together make up the year. How many months are there in the year? Twelve months. Yes, and each of the seasons is of the same length. Who can tell me how many months in each season?

Well, we will now talk about the Spring. When does the spring come? After the winter. What kind of weather do we get then? The weather begins to get warmer. Yes, the very cold weather is gone and the sun begins to stay with us longer each day, and looks brighter and makes us feel warmer. Do you not remember in the winter you were obliged to have a candle before you could get up? When you came out of school in the afternoon it was dark, and very often the teachers had to light the gas before school was over. Now the mornings are not so dark, and you are able to get up without a candle.

Did you have the gas in school yesterday? No, we do not have the gas now. Why not? Because we are able to see without. If we go out into the fields and gardens in the winter what do you notice about the trees? They look dead—there are no leaves on them. Well, in the spring you see them all beginning to grow. The buds on the trees are bursting into green leaves, and as the spring goes on the leaves can be seen all over the trees. And the pretty flowers or blossoms cover the trees, and make them look very pretty. Can you tell me some of the trees that have pretty blossoms on them? Yes, the apple, the pear, the plum. Yes, these are our fruit trees. Then the horse chestnut is very pretty with blossoms. Then if we look at the garden we shall find the flowers feeling the weather is getting warmer, as they begin to grow and burst out into bloom.

Can you tell me some of the pretty spring flowers? The crocus, the violet, the primrose, the daffodil, the tulip, the wall-flower. That will do. Besides these pretty flowers, you will be able to see everything in the garden is beginning to grow. The gardeners are very busy, sowing seeds and planting for the summer flowers.

Then if you watch the birds you will find them very busy indeed. Have you seen them flying about with bits of straw and wool in their mouths? They get these things to build their nests. Why do they build nests? Yes, this is the time of year the birds lay their eggs. I daresay you will wonder where so many of the birds come from. They have been to a warmer country during our cold winter, and when the spring comes back, they come to us again. Can you tell me the names of some of these birds?

Section III.—Scenes of Common Life.

LESSON—WRITING A LETTER.

I. Introduction.—Now, children, when do you have holidays? In the summer and at Christmas. What do you do in your holidays? The teacher, of course, to this question would obtain many different answers. Well, Mary, what do you want to say? I went into the country. Did any one go with you? Yes, my father, mother, and sister. James says he also went into the country to see his aunt, and nobody went with him. Were you happy while you were there? Did you ever think of your father and mother? Did you want to speak to your mother? Yes, I wanted to tell her how happy and how well I was, and what fun I was having every day. Why did you not tell her? Because I was such a long way from her. Well, how could you let your mother know all you were doing? By writing a letter to her.

Now I want you all to help me this morning to write a letter, and we will suppose we are in the country and sending word home to our mother. On what shall we write the letter? On paper. Who can tell me what we call the paper we use for letters? Yes, it is called note-paper. Come and show me some note-paper. What do we call each piece of paper? A sheet of paper. What colour is it? It is white. Have you seen any note-paper that was not white? Yes, I saw some blue note-paper. Harry says he saw some yellow paper; another little boy says his mother had some pink paper, and Jane says she has some green note-paper. Now look at this pink, yellow, green, and blue note-paper, and tell me what kind of colours they are? They are all very light colours. What else can you tell me about this paper? It feels very smooth, and you are able to fold it.

II. Contents.—Now how shall we begin our letter? Well, see here is a letter I had this morning. What can you see has been written first? Something in the corner. In which corner? In the right top corner. I will read it to you. This is what is written here: '27, Silver Street, Southend, July 14th, 1884.' What do you think that tells you? Yes, it is the place where the little boy is staying. Do you know what we call this? Yes, the address. Why do we want to write the address? Yes, that is right; it is to let the person to whom we are writing know where we are. Why? So that he can write back an answer to us. What do we call 'July 14th, 1884?' The date or time. Of what does the date consist? The month, the day of the month, and the year. Why must we put the date on a letter? So that the person to whom we are writing may know exactly when we wrote the letter. If we did not put the date on the letter, and said, 'I shall be home to-morrow,' your mother would not know which day you meant. Why would she not know? Because she would not know on which day you wrote the letter. Can any of you tell me what is the date of to-day? What month is it? What year?

Now let us see what comes next in the letter; will you read it, Mary? 'My dear mother.' That is right. If you were to write to your father, what would you put? What to your sister? Now we will write a letter on the blackboard. What do we put first? The address. Where shall I begin? Near the right top corner. Tell me the address of the school. What must I write next? The date. What is the date to-day? Where do I write the date? Under the address. What have I to write next? The name of the person to whom you are writing. Where do I write it? Do I write it under the date. Well, look at this letter and tell me where the name is? On the left side of the paper. Do I put it at the top on the left side? Oh no, lower down than the date. The blackboard would then have on it:—

Hope School,
Pleasant Road,
London, N.,
20th October, 1884.

My dear Mother,—

What do you put after that? You then begin to write down all the news you have to send. The teacher should

then get the children to compose a letter, and as they proceed she should write it on the blackboard.

Now, I want you to look again at this letter. What do you call this part of the letter? The end. What do you see at the end? A name. Whose name do you think it is? The name of the person who wrote the letter. And what can you see just above the name? Three words. We will ask Harry to read them to us. 'Your loving son.' Yes, we always write something like this before we write our name. If a little girl wrote a letter to her mother, what would she put? 'Your loving daughter.' And if she were writing to her brother or sister, what would she write? 'Your loving sister.' And what would a little boy put? Sometimes we write, 'Your affectionate son,' instead of 'loving son.'

Now, we must finish the letter on the board. What shall we put? Why is it necessary to put our name in the letter? We should not know who had sent us the letter. The teacher should explain about letters going to the wrong house, and also going to houses when the people have removed, and how the postman takes these letters back to the post-office. Here they are opened, and then the name and address inside enable the postman to return them to the writers of the letters.

III.—What is done with the letter after it is written? It has to be folded. Into what size? A size that will fit the envelope. Of what use is the envelope? It holds the letter safely. It keeps it clean. And what else? When the letter is in the envelope can you see the writing? Well, then, the envelope prevents the postman or anybody else from reading the letter. What do you do when the letter is in the envelope? Fasten it. How can you do this? There is some gum on the envelope, and when you wet the gum and press the envelope it keeps shut. Now, what else must you do? Write on the envelope. What do you write? The name of the person to whom you have been writing and the address. Why do you do this? In order that the postman may know where to take the letter. What do you do after you have written the address? Put it in the post. But you must put something else on the envelope. What is it? A postage stamp. Where do you get that? At the post-office. What is the use of the stamp? It shows that the letter is paid for. How much did you pay for the stamp? A penny. Well, if you had not put a stamp on, the person to whom you wrote would have had to pay twice as much. How much would that have been? When the stamp is on how much does he have to pay? Nothing. Where shall we post the letter? In the pillar-box. Does it stop there? Who takes it out? The postman. What does he do with it? He takes it to the post-office with all the others. Yes, and then they are sorted and given to the postmen to take to the different houses.

Section IV.—Common Employments.

LESSON—THE PAINTER.

Apparatus—Various coloured powders, linseed oil, turpentine, white lead, putty, sand-paper, pumice stone, and a few brushes.

I daresay you can all tell me some things that the carpenter makes. Now, when he has made the doors, windows, cupboards, etc., are they quite finished? Well, perhaps you can tell me what has to be done to the windows? The glass has to be put in. Who does this? The glazier? Something else has to be done to all these things. What colour is the wood when the carpenter has finished? Are they the same colour when we live in the house? What changes the colour of the wood? The paint. Who paints the wood? A man called a painter. Now, I should like to have a long talk with you about the painter. Do you know what he has to do first? Will you tell me some of the things he uses? Paint and brushes. What is this I have here? Some paint. What can you tell me about it? It is green. Is paint always green? No, it is of different colours. Tell me some of them. Can you tell me now what the painter has to do first? Yes, he must get his paint ready. We say he has to mix his paint, because the paint is made of a number of different things mixed together. Here are some of the things the painter uses to make his paint. What is this? It is oil. Yes, it is *linseed oil*. This is called *white lead*. Then this is very much used, and if you smell it I expect you will be able to tell me its name. It is *turpentine*. Then the painter has to put in something to make the colour. Will the same thing do for all the colours? No, if he wants yellow paint he must have some *yellow powder*. If he wants red he must use *red powder*. Here are some different powders, and I want you to tell me their colours. What colour is this? And this? And this one? etc. Then besides these, the painter uses other things, but these you must learn another day. Where does the painter put the paint when he is going to use it? In the paint-pot.

Now, look at these paint brushes. What can you tell me about them? They are all long. Which part is long? The handle. Of what is it made? It is made of wood. Why does the painter want a long handle? To hold the brush, and keep the paint from getting on his fingers. Why does he not like it on his hands? Have you had any paint on your hands? How did you get it off? Could you wash it off? No, mother had to rub some grease on my hands, and then it came off. Yes, but besides that, the paint sometimes makes our hands very sore. So you see you must be careful not to touch the paint. How is it when I touch this door the paint does not come off on to my hands? Because the paint is dry. Is it dry when the painter puts it on the door? When is it that you must not touch paint? When it is wet. Now, look at the brushes again, and show me another part beside the handle. Of what is this part made? Of hair. We say it is made of bristles. Feel how soft they are. The painter does not like a hard brush. Are all the brushes the same size? No, some are large, and some are small. Do you know why the painter wants brushes of different sizes? Well, perhaps, you will be able to tell me some other time, when you have watched the painter at work.

When the painter has his paint and brushes ready he has to look at the wood he has to paint. The wood must be very smooth. If there are any nails in it he gets a punch and knocks the heads of the nails into the wood. This leaves a number of small holes, and these the painter fills up. What does he use to fill up the holes? Some putty. All the rough places he rubs with sand-paper or pumice stone. What does this do to the wood? Who can show me the pumice stone? Which is the sand-paper?

Now the wood is quite ready for the paint. Who has seen a painter at work? How does he move the brush? Yes, he moves it up and down. Why does he not move it about any way? The painter wants the paint to be very smooth and not to show the marks of the brush, and he does not press very hard. If you watched him carefully you will see that after he has painted the wood once he lets the paint get quite dry and then he paints it all over again. We call this putting on another coat. How many coats would that make? Two. Sometimes they put on three or four coats. Of what use is this paint? Yes, it makes the wood look better, and the house looks more finished. There is, however, another reason why we paint the wood. It keeps the wood from rotting or wearing away. When the wood is outside the house the rain would soon rot it if it were not painted. We say the paint preserves the wood. Then again: sometimes when boys and girls are playing their hands are dirty, they put them on the paint and make dirty marks. What does your mother do then? She washes the dirty marks off the paint. Can she wash the paper on the walls? No; it would spoil the paper. The *summary* written on the blackboard would be as follows:—

The painter uses paint and brushes.

The paint is made of white lead, linseed oil, turpentine, coloured powder, etc.

The painter's brushes are made of long handles and soft bristles.

The painter puts on several coats of paint, and each one must be dry before the next goes on.

LESSON—PAPER MAKING.

I. *Qualities.*—What have I in my hand? Look at it and see what you can tell me about it. Is it white? Yes, is this piece white? Is this piece blue? What colour is this? What will you say about the colour of paper? Paper is of different colours. How does it feel? It feels very smooth; it is thin and light. What am I doing to it now? Folding the paper. Then you see we can fold paper. What do we say of those things that we can fold? We say they are pliable. What am I doing to the paper now? Tearing it. How would you say it tears? Very easily. What else can you tell me about paper? Why does your mother use paper when she lights the fire? Because it burns quickly? Then you see paper burns easily and with a flame. What do we say of those things that burn with a flame? They are inflammable. Now we will write on the blackboard what we have learnt about paper.

II. *Of what made.*—Now look at these pieces of paper. Can you think of what it is made? See I have here some mixed rags. Can you believe that paper is made from rags like these? Well, most of these pieces of paper were made from rags, and nearly all the paper we use is made from them. Then besides the rags there are some other things used for making paper; here are some of them. The teacher should then show the children some rope, grass, straw, and waste paper. Sometimes you can see small pieces of straw in brown paper. Do you not think it is very wonderful to be able to turn these things into nice paper like this?

III. *How made.*—Well, I daresay you would like to know how the men make these things into paper. I will tell you a little about it now, and when you are older you must read more about it. Do you know what we call the people who make paper? Yes, they are called papermakers. How does the papermaker get the rags to make into paper? Well, what does your mother do with her rags? She sells them. To whom does she sell them? To the man at the rag-shop. Yes, and if you go to the rag-shop you can see large sacks full of rags. These are sold by the man to the papermaker. So you see the papermaker can get plenty of rags. What kind of rags does he get? All kinds. Yes, he gets old and new, dirty and clean, and all sizes and colours. Then what do you think the man does with them? That is quite right, Harry; he must sort them. He separates the clean from the dirty. They are then put into a machine that turns round and round and shakes the rags about. The bottom of the machine has many small holes, and through these a great deal of the dirt and dust falls out. There are some sharp knives in the machine, and these cut the rags into small pieces. The rags are then boiled, and something is put in with them that makes all the rags quite white and clean. When they are quite white and clean they are put into another machine which has a great many knives in it. These knives turn round and round. What do you think becomes of the rags in this machine? They will be cut into very small pieces. Yes, the rags are cut in the smallest pieces possible. After this something is done so as to turn these pieces into what is called *pulp* (some of this should be shown). What is this pulp like? Thick milk or cream? What is it really made of? Of the rags beaten up very small. The pulp is then pressed through a machine which squeezes all the water out of it, and rolls and presses it on thin wire gauze (some of this should be shown), and when dry it is paper.

IV. *Summary.*—This should be written on the blackboard as the lesson proceeds.

Paper is smooth, thin, light, of different colours, pli-a-ble, very easily torn, and in-flam-ma-ble.

Paper is made of rags and other things, as rope, grass, straw, and waste paper.

When it is made of rags, the rags are: 1, sorted; 2, put in a machine that shakes the dust and dirt out; 3, boiled to make them white and clean; 4, another machine cuts them into tiny pieces; 5, then beaten into pulp; 6, made into paper.

(To be continued.)

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My Certificate Answers.

BY ARTHUR DAY,

Assistant-Master, Bridge Street, 7th Standard Technical School, Birmingham; First in the First Class at the Borough Road College, Christmas, 1883.

(Continued from page 411.)

POLITICAL ECONOMY.

Define capital. Distinguish fixed and circulating capital. Discuss the statement that the industries of a country are limited by its capital.

Capital is that part of wealth which is put aside to assist in future production.

Circulating capital is all consumed in fulfilling its office once, as, for instance, wheat sown by a farmer does not do for several years, but the field must be re-sown every year.

Fixed capital exists in a substantial form, and is only gradually consumed, as the plough, the horses, etc., of the farmer, which last for years, and assist in several successive periods of production.

In order for there to be industries, there must be capital. Let us suppose a barbarian tribe living from hand to mouth; as the food comes daily it is eaten. Not having any stores, they cannot sit down and work at any trade, for their time is taken in the chase, or other form of a daily struggle for food. If by any means they came across a store of food, then they might employ their time in any industry they pleased until the stock of food had vanished. In a civilised country there must always elapse a certain time before the articles manufactured bring their returns, but the artisans cannot wait six weeks for food; they must have food, firing, clothing, etc., at once; the materials for turning out fresh work must be advanced; and hence, if the master has not these things or the money necessary to procure them, the industry is at a standstill.

Prove by illustrations that the rate of wages is principally regulated by competition, and name some of the circumstances which practically modify the action of competition.

An advertisement for a clerk fetches hundreds of applicants. Why? Because there are so many who, having had a small education and wishing to appear gentlemanly, would take the place. Now, if the salary were £100, there would be a certain number of applicants; if it were reduced to £80, several would withdraw; and so on until at last only a few would consent to take the situation.

Competition is modified by certain class considerations, and by the amount of money it costs to learn the trade or profession. For instance, in order to become a lawyer, a long term of study and waiting for clients has to be experienced, which take much capital; also the lawyers regulate competition by regulating the number of articled pupils.

Again, the wages of miners are high, because many would not consider it respectable enough to be a miner; others would not have a constitution strong enough to stand it, or have had experience.

What gives value to a Bank of England note and to an ordinary cheque drawn by a private person on his banker? How do banks employ the money of their depositors?

A bank-note is a promise by the chief cashier on behalf of the governors to pay the sum named thereon to bearer on demand. As long as the bank is solvent, and does not stop payment, anybody by presenting the note can receive the amount. A cheque orders the bankers it is drawn upon to pay some one (bearer or otherwise) the sum stated from the accounts of the

one who signs the cheque. As long as money stands to this man's credit, and his bankers are solvent, the cheque is worth the sum stated; on failure of either of these conditions, it loses its value.

The money deposited in banks is invested by the banks in various ways, such as lending it to a Government, or taking shares in railways, canals, mines, etc.

Show that the rent of land is regulated by the excess of its produce over that which would be produced on the worst land in cultivation with the same expenditure of labour and capital.

Let us suppose a farmer A, who only secures returns enough from his land to pay him the current rate of interest on his capital. He would pay no rent, for if rent was charged he would withdraw his capital and invest it so as to get the current rate. If, now, another farmer, B, gained more by his land, he must pay rent, otherwise other people, seeing him gaining more than the current rate of interest, would offer the landowner some rent to have the land instead. But if the landowner asks B for more rent than his excess of produce over A, B will prefer to cultivate land similar to that of A, and no one else will take his land unless he can gain the current rate. Hence these fluctuations on either side would soon determine the rent as stated.

Enumerate the principal advantages arising from the division of labour in the production of any article in common use.

A Pen.—One man stamps it from the rolled steel, another bends it to shape, another hardens it, another scours it, and so on. Each man becomes very dexterous in his particular duty, more dexterous than if he devoted his time to different duties. Also by continually working at one process he does not lose time in having to change his tools or pass from one occupation to another, and each man can be used for the duty which is most suitable for him. Some men could not stand the heat of a furnace or lift heavy articles, others would not have inventive capacity for new designs.

Illustrate the statement that uncertainty of success has considerable influence in regulating the remuneration of any employment.

A man studies for the law. Desiring to become a barrister, he risks a large sum of money in preparing himself, and he is not at all certain that when fully qualified he will have clients, or that he will ever make a name. If he does, he then will ask high remuneration in return for the risk, and he will be able to get what he asks, because many men will have been deterred by this uncertainty from entering the profession.

An agricultural labourer can often demand good wages in the colonies, because the uncertainty of obtaining employment has deterred others from emigrating, and consequently, the supply being small, he can get better wages.

What is generally understood by the 'natural value' of any article? Show that the value of all things that cannot be be indefinitely increased is governed by demand and supply.

By 'natural value' of any article we mean its intrinsic value, that is, the amount of another commodity it will exchange for, and which amount will vary according to the value of the first article not of the one it exchanges for, which would 'extrinsically' affect the price.

Suppose there are 10 plots of land for sale in a fertile and healthy locality, and possessing other advantages. Many persons would desire these plots, and there might be 100 willing to give £1000 for each, but only 50 of these would give £2000, 20 would give £3000, and so on, until at a certain price 10 would be the only ones remaining, and these would have the lots. The demand here has raised the price. But if it had been possible to throw 10 more plots in the market the 20 desirous purchasers at £3000 would have all been accommodated, and the greater supply would have diminished the price.

14. Prepare the outline of a lesson to an advanced class on one of the following:—

(*a*) The relations of capital and labour;

(*b*) The considerations which govern the rate of wages;

(*c*) Councils of conciliation and arbitration between the employer and the workman.

(*b*) Take up daily paper. Read advertisement for errand-boy or office-boy, and ask how many would go? Some hesitate. Why? 'Please, sir, what's the wages?'

'Suppose all you boys went, and offered yourselves,' etc.; thus trace out that many offering, would lead to him giving low wages; and only few applicants, to higher wages. Write on board, 'If supply is greater than the demand prices (or wages) fall.'

Now begin to add conditions:—

Pleasantness, or unpleasantness (as miners).

(1) Must be there from 6 a.m. to 10 p.m. How many would go now? Fewer hands than before. Why? Not *pleasant* to work so long; write down on board, 'Pleasantness or unpleasantness,' and from the statement above let them see that if the task is disagreeable wages would be higher, and *vice-versâ*.

Ease or difficulty, cheapness or expense of learning (doctors, mechanics).

(2) Must know book-keeping, speak French, etc. Few again. Why? Because these things are hard to learn, and cost money. As before, show how the number affects wages, and ask if interpreters get good or bad wages.

Constancy or inconstancy (builders).

(3) Only employed three days a week. As before some would not go. Ask why? They want *constant* employment. Mention again, 'If few are willing then wages higher.'

Amount of trust (cashiers).

(4) Must have good testimonials for honesty, and be greatly trusted. Trace out how it affects wages. Do bank cashiers have small or large salaries?

'Chance of success' (lawyers, doctors).

(5) In a year be paid 30s. a week. All are ready to go. Only be paid if no mistakes are made. Not many. Hence, 'chance of success' affects number applying and affects wages. Recapitulate all these points, which should previously have been written on B.B. And let the boys supply instances in trade of high or low wages as a consequence of each cause, and write these opposite the cause.

School Management.

SCHOOL REGISTERS.

1. When, and by whom, should the daily attendance and absence of scholars be marked and verified? How would you endeavour to secure correct marking, and what should be done in case of error, or the withdrawal of a child during school hours?

Give an extract from an attendance register for one week; explain the marks used, and show how the particulars required in the book of summaries should be obtained.

Specify, in detail, the rules with regard to—

(*a*) Calculation of average attendance.

(*b*) Removal from the registers, and re-admission.

(*c*) Qualification of a scholar for entry on the examination schedule.

The daily attendance should be marked by the responsible teacher of a class (*i.e.* head-master, assistant, or pupil teacher above second year). To secure correct marking call the names, and let every one present answer, 'Here, Sir!' then count up the column the number marked present, count the class, and the two totals should coincide.

In case of error correct by a foot-note. If a child is withdrawn during school hours a mark should be drawn across the attendance mark, and the total at the bottom corrected by a footnote. (See extract.)

To calculate the average attendance divide the total number of attendances made by the number of times the school has been open.

A child may be removed from the register and marked left if absent 6 weeks, or before this, if definite information as to withdrawal has been received.

On re-admitting such child a new admission number must be assigned to it.

NAME.	M		TU		W		TH		F		TOT.
Alton, Fred.	/	\	/	\	*a*	\	/	\	*s*	*s*	7
Brown, Thom.	*a*	...	L	E	F	T	...	...	...	...	0
Banks, Will.	/	\	/	\	/	\	/	\	/	\	10
Cook, George.....	/	\	×	\	/	\	/	\	/	\	9
Jones, Walt.	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	*a*	0
King, John.....	/	\	/	\	/	\	*a*	*a*	/	\	8
Morris, Will.	/	\	/	\	/	\	/	\	/	*a*	9
Smith, Alf.	*a*	\	*a*	\	*a*	\	*a*	\	*a*	\	5
	5	6	4/4	6	4	6	4	5	4	4	

Total Attendances	...	...	48
No. present at all	...	...	6
No. on register	...	...	7

A scholar is qualified to be put on the examination schedule if its name has been on the register during the last 22 weeks of the school year, *i.e.*, its name must have been on at the beginning of this period and continue on.

The marks on the extract above—

/ morning attendance.
\ afternoon ,,
a absent.
s ill.
× attendance cancelled.

The figures at the bottom indicate the numbers present at each opening of the school.

The figures at the side, the total made by each child for the week.

The particulars for the book of summaries are given underneath. Add up column of totals for the total attendance. Count number of those who had any attendance marked, for 'No. present at all.' Count number of all those not marked left, for 'No. on register.'

2. On what principle would you classify your scholars, if you were called on to organise an entirely new school? Say what advantages, if any, there are in making separate classification for special subjects; and what are the reasons in favour of the ordinary practice of keeping the same scholars together for the whole of their instruction.

I should classify them according to their ability in 'reading' (unless, of course, they had at other schools passed any standard); because reading tests a child's general ability; arithmetic only shows a special aptitude, and writing a correct eye and steady hand; for this reason it is advantageous to have separate classification, as some children do have an inherent aptitude for figures, others for writing, etc., and these should be allowed to go forward, not held back by others.

On the other hand, the general method places a child continually in competition with the same children, and if he wishes to hold his own, or rise, he can only do it by striving to improve in the branch he is backward in. Also the teacher has the same children continually under him, and consequently knows them better, and brings them forward in all branches of their education. Another reason is that the working of the school is greatly simplified.

What is meant by 'habit,' and by what means is habit formed and strengthened? Are there any youthful habits, either of thought or of action, which lie specially within the control of the school teacher?

Habit is a tendency of the body or mind to act in a particular way when subject to certain conditions, without seeming to be influenced directly by the will. Thus a well-bred person on entering a house will remove his hat, though engaged in conversation; the hand will rise to the head because the habit is formed. Habit is formed and strengthened by continued and uninterrupted repetition of the acts, at first with only small intervals in between, and with no exceptions, afterwards at longer intervals. Such habits as cleanliness, politeness, attention, concentration of mind and abstraction from hindrances, prompt obedience, doing everything as well as possible—all these are habits which may be instilled by the teacher.

14. Mention any books relating to the History or the Philosophy of Education which should be read by any one who is anxious to become thoroughly qualified for the profession of a teacher, or which you hope to read at leisure after your college course is complete, and give your reasons for the selection.

Spencer 'On Education;' *Bain*, 'Education as a Science;' *J. S. Mill*, 'Psychology.'

All these books give an insight into the development of the intellect, and how this natural method should be applied by a teacher to his work.

Locke 'On the Understanding;' 'Thoughts on Education; *Roger Ascham*, 'The Schoolmaster.'

Lives of some educationalists, as Pestalozzi, Dr. Arnold, etc. These will enlighten on the thoughts of men at other periods beside our own, and comparison will be instructive.

Show by means of brief notes of a lesson on *one* of the following subjects, how you could help a scholar to think out and find a rule or principle for himself:—

(1) Multiplication of Fractions.
(2) Laws of Gravitation.
(3) Choice of Food.
(4) Difference in the rate of wages.
(5) Formation of abstract nouns from adjectives.

Apparatus.—Several little squares of wood, and some larger rectangles that are multiples (as 12, 6, 10, etc.) of these.

Build up a rectangle of 6 squares same size as one piece. Show it to be of the same size, and then divide the 6 into two groups of three. Ask what fraction? $\frac{1}{2}$. Now ask for a third of one of these groups, namely, one square, and elicit that this is one $\frac{1}{3}$ of the large one. Write on board $\frac{1}{3}$ of $\frac{1}{2}=\frac{1}{6}$. Repeat the operation in various ways, as $\frac{1}{3}$ of $\frac{1}{4}$, $\frac{1}{4}$ of $\frac{1}{5}$, $\frac{1}{5}$ of $\frac{1}{2}$, etc. Write down one underneath another, and then let the boys notice the result, and tell you the connection of parts; they will soon see that $\frac{1}{3}$ of $\frac{1}{2}=\frac{1}{6}$, that the 3 is × by 2.

Now do some more in the same manner, with such as $\frac{2}{3}$ of $\frac{3}{4}$ (with 12 squares)$=\frac{6}{12}=\frac{1}{2}$; $\frac{2}{3}$ of $\frac{2}{5}$, $\frac{3}{4}$ of $\frac{2}{3}$, etc.

Now the boys will notice that the numerators are multiplied as well, and after numerous instances they will give the rule to 'Multiply together all the numerators and all the denominators.'

Say by which of the exercises of Fröbel or by what other discipline in higher classes can the inventive faculty of children be strengthened.

By exercises, such as the construction of solids with peas and wooden rods, forming eggs, nests, etc., of pipe clay, children in low classes would be disciplined. In higher classes a course of inventive geometry is recommended by Spencer; constructing plane geometrical figures with wire or cutting them out in paper; constructing solids of cardboard or tin by marking out the development, scoring the card, and doubling to shape; very little apparatus is needed, and every teacher of geometry should let the models be constructed by his class, at any rate with cartridge paper.

In the lower classes as well there are the exercises with coloured paper, forming patterns by weaving strips together, and various shapes by doubling can be made.

If your advice were asked by the managers, respecting the formation of a lending library in your school, what classes of books would you suggest? Name in each case two or three examples of books well suited for the purpose. By what other means is it in the power of a teacher to encourage in the scholars a love of reading?

Books of Travel, etc., as 'Robinson Crusoe,' 'Cook's Voyages,' 'Swiss Family Robinson.'

Natural History—Rev. J. Wood's 'Stories about Animals,' 'Anecdotes of Dogs,' etc.

Books for the Imagination—Andersen's and *Grimm's* 'Fairy Tales,' *Æsop's* and *Mrs. Prosser's* 'Fables.'

Fiction—Jules Verne's works, *Scott's* 'Ivanhoe,' etc.

Tales of Home Life—as 'Wide, Wide World,' 'The Gates Ajar,' 'Uncle Tom's Cabin,' etc.

Observation—'Sandford and Merton,' 'The Wonders of the Sea-shore.'

Poetry—Scott's, Macaulay's, Longfellow's, 'Tennyson for Children.' Some of *Shakespeare's.*

Biographies—Smiles' 'Life of Stephenson,' etc.

I should encourage a love of reading by continually in lessons referring to books, mention books of travel in geography lessons, biographies in history lessons, and devote a short time each week on Friday afternoons to reading from some well-known book,

allowing the children to bring a copy from home, and by giving occasional lessons on some authors' lives and works, reading selections.

It has been officially explained that one of the chief objects of exercises in English should be to add to the scholars' store of words. Say why it is desirable to do this, and by what sort of exercises the object can be most effectively attained.

It is desirable for a child to have a good store of words, for then it can express itself clearly, it can understand what others say, and can appreciate books. Also it is impossible to have a good store of words without a knowledge of the *things* referred to, and this must always be borne in mind in exercises of this kind. It is no use to tell a child to cram into its head a page of a dictionary, but select anecdotes, and later on good descriptive poetry, read it with them, point out the things referred to, and describe in their language the same scenes; let them afterwards write on their slates from memory the substance of the passage n their own words, and they will soon be able to combine the expressions of the book with their own language. In regard to poetry, *after* this kind of exercise they should commit the lines to memory, but it is no use so doing unless they previously thoroughly understand it and have a real knowledge of it.

PENMANSHIP.

Parenthetically.

The castled crags of Drachenfels.

It would be absurd to suppose that any of the constituent elements of military genius, which nature furnishes to energetic characters, were wanting to the leaders of a barbarian or feudal army; untroubled perspicacity in confusion, firm decision, rapid execution, providence against attack, fertility of resource and stratagem, these are as much required from the chief of a guerilla horde as from the accomplished commander. But rarely are they so consummated by habitual skill as to challenge the name of generalship.

List of Books Used.

Todhunter's *Algebra.*
Pott's *Euclid.*
Wrigley's *Mathematical Problems.*
Shakespeare's *Julius Cæsar.* Edited by Aldis Wright.
Bacon's *Essays.* Edited by Dr. Abbott.
Mrs. Fawcett's *Political Economy.*
Macaulay's *Essays on Lord Chatham* and *Warren Hastings.*
Curtis' *History of England.*
Ludlow's *History of the American War.*
Locke's *Thoughts on Education.*
Hachette's edition of *Lazare Hoche* and *Iphigenie.*
Dr. Smith's *French Principia.* Pt. I.
Baume's *French Grammar.*
Spencer's *Education.*
Rev. Stopford Brooke's *Sketch of English Literature.*
Hullah's *Grammar of Musical Harmony.*
Science and Art of Teaching. (National Depository.)
Shakespearian Grammar. Dr. Abbott.

Recent Inspection Questions.

[*The Editor respectfully solicits contributions—all of which will be regarded as* STRICTLY PRIVATE—*to this column. For obvious reasons, it cannot be stated in which district the questions have been set.*]

Arithmetic.

STANDARD I.

369	708	
407	367	
58		
987	341	Ans.
12		
1833	Ans.	

STANDARD II.

(1) Multiply ninety-five thousand and seventy-six by nine. Ans. 855,684.
(2) Multiply 67,249 by 87. Ans. 5,850,663.
(3) Divide 64,207 by 11. Ans. 5,837.
(4) A lady had 350 yards of calico. She kept 120 yards, and divided the remainder among ten women. How many yards did each receive? Ans. 23.

STANDARD III.

(1) Divide one hundred and nine thousand, six hundred and eighty by ninety-eight. Ans. 1119+18.
(2) From sixty thousand and four pounds, nine shillings and twopence farthing take eight hundred and seven pounds, thirteen shillings and eleven pence halfpenny. Ans. £59,196 15s. 2¾d.
(3) Add together £6 2s. 9½d.; £504,290 16s. 8½d.; £9,760 18s. 11¾d.; £93,278 9s. 4½d.; £602,190. Ans. £1,209,526 7s. 9¾d.
(4) I borrowed £10, and shall pay back £1 9s. 4d. on Monday, 9s. 6d. on Tuesday, £2 7s. 6d. on Wednesday, and £4 1s. 7d. on Thursday. How much must I pay on Friday so that I may then not owe anything? Ans. £1 12s. 1d.

STANDARD IV.

(1) £6,073 14s. 6¼d. × 87. Ans. £528,414 3s. 3¾d.
(2) Divide two hundred and six thousand, nine hundred and eight pounds, three shillings, and a farthing by twenty-nine. Ans. £7,134 15s. 3¼d.+8.
(3) Reduce 605,978 inches to miles, etc. Ans. 9 mls. 4 fur. 20 po. 2 yds. 2 ft. 2 in.
(4) Divide £2 17s. 5d. among 17 persons, so that one may have 5 shillings more than each of the others. Ans. One has 8s. 1d.; the others have each 3s. 1d.

STANDARD V.

(1) 309 things at £47 1s. 8½d. each. Ans. £14,544 1s. 5½d.
(2) Find the cost of 36 ac. 2 rds. 19 po. of land at £6 3s. 4d. per acre. Ans. £225 16s. 3¾d.
(3) Make out a bill for 17 lbs. of sugar at 5¼d. a lb.; 15 lbs. of tea at 2s. 9½d. a lb.; 3 doz. oranges at ¾d. each; 9 balls of string at 1s. 6d. per dozen balls. Ans. 8s. 1¾d. + £2 1s. 10½d. + 2s. 3d. + 1s. 1½d. Total £2 13s. 4¾d.
(4) A garrison of 2,100 men has provisions for 9 months, but receives an addition of 600 men. How long will the provisions last? Ans. 7 mos.

STANDARD VI.

(1) Simplify $\frac{8}{9}$ of $6\frac{3}{4}+\frac{17}{20}$ of $\frac{4}{51}-\frac{6}{7}\div 1\frac{1}{11}$. Ans. $5\frac{4}{15}$.
(2) Divide the product of ·0136 and 16·2 by 3060. Ans. ·000,072.
(3) If £12 will pay 8 men for 5 days' work, how much will pay 32 men for 24 days' work? Ans. £230 8s.
(4) Find the interest on £3,256 15s. for 5 years, at 2½ per cent. per annum. Ans. £407 1s. 10½d.

STANDARD VII.

(1) A man buys goods for £23 5s. 5d, and sells them for £22 2s. $1\frac{3}{4}$d.; how much does he lose per cent.? Ans. 5 per cent.

(2) Find the present worth of £678 8s. due 16 months hence at $4\frac{1}{2}$ per cent. Ans. £640.

(3) What is the annual income derived from investing £6050 in the 3 per cents. at $90\frac{3}{4}$?

Ans. £200.

(4) If $\frac{5}{7}$ of the cargo of a ship be worth £16,200, what is the value of $\frac{2}{3}$ of $\frac{7}{8}$ of the remainder?

Ans. £3780.

Dictation.

STANDARD I.

Words for dictation:—Blue, chair, flower, house, night, plant, summer, table, truth, world.

STANDARD II.

(*a*) A crow, ready to die with thirst, beheld a pitcher at some distance, and flew to it with joy. When he came to it, he did indeed find water in it, but so near the bottom, that with all his stooping and straining he was not able to reach it.

(*b*) The next day the giant came and looked at Dick, and finding that he had eaten none of the bread, he took him by the head, and crammed some of the bread down his throat. Poor Dick, who was nearly choked to death, was in too great a fright to think of eating or drinking.

STANDARD III.

(*a*) So the little girl wandered about barefooted, with a quantity of matches in an old apron, whilst she held a bundle of them in her hand. Hungry, and pinched with cold, she crept along, the large flakes of snow covering her yellow hair which curled round her face. It was dreadfully cold, and was beginning to grow dark.

(*b*) Everybody knows that the sparrow is a small, stout, active, and sometimes very noisy bird; not clad in any gay plumage, like some of its neighbours, but very happy and contented in its humble station, and generally in good spirits. As a rule it is rather sociable, and likes the company of its fellows.

STANDARD IV.

(*a*) Thus had George Stephenson, the poor fireman's child, become a great and celebrated man. He had fought a hard battle, and, but for his wonderful perseverance, would many a time in his youth have been discouraged and cast down. Now he was greatly sought after, both at home and abroad, and was honoured by kings and princes. Yet he was still the same humble-minded man, and never forgot his poorer friends in the time of his triumph.

(*b*) We thought as we hollowed his narrow bed,
And smoothed down his lonely pillow,
How the foe and the stranger would tread o'er his head,
And we far away on the billow!
But half of our heavy task was done
When the clock struck the hour for retiring;
And we heard the distant and random gun
That the foe was sullenly firing.

Parsing.

STANDARD IV.

(*a*) Near the end of the lane we met several children on their way to school.

(*b*) My young friend went to Blackpool yesterday at nine o'clock.

STANDARD V.

(*a*) They will return when the weather is milder.

(*b*) The teacher placed the flowers, which the children brought with them, on the table by her side.

Writing.

STANDARD V.

Dictation.—It was on Friday morning, the 12th of October, 1492, that Columbus first beheld the New World. As the day dawned, he saw before him a level island, several leagues in extent, and covered with trees like a continual orchard. Though apparently uncultivated, it was populous, for the inhabitants were seen issuing from all parts of the woods, and running to the shore. On landing, he threw himself on his knees, kissed the earth, and with tears of joy returned thanks to God.

Composition.

STANDARD VI.

(*a*) Make up a short story about a clever dog, by enlarging the following outlines:—

(1) A gentleman stops his gig in front of a shop.
(2) Leaves his dog on the seat.
(3) Horse takes fright, and runs away.
(4) Dog jumps down, seizes reins in his teeth, and stops horse.
(5) Thanks of his master.

(*b*) Write a short theme about the duty of kindness to animals.

Parsing and Analysis.

(*a*) I saw from the beach, when the morning was shining,
A bark o'er the waters move gloriously on.

(*b*) Where once we dwelt our name is heard no more.

—o—

ANSWERS TO
Pupil Teachers' Examination Papers.
OCTOBER 25TH, 1884.
FIRST YEAR.

Pupil Teachers at end of First Year.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Reduce to a simple fraction $\dfrac{\frac{1}{2}+\frac{1}{3}-\frac{1}{4}}{\frac{1}{2\frac{1}{2}}+\frac{1}{3\frac{1}{2}}-\frac{1}{4\frac{1}{2}}} \div \dfrac{2\frac{1}{2}}{3\frac{1}{2}}$.

$\dfrac{\frac{1}{2}+\frac{1}{3}-\frac{1}{4}}{\frac{1}{2\frac{1}{2}}+\frac{1}{3\frac{1}{2}}-\frac{1}{4\frac{1}{2}}} \div \dfrac{2\frac{1}{2}}{3\frac{1}{2}}$

$$= \frac{\frac{1}{2}+\frac{1}{3}-\frac{1}{5}}{\frac{1}{2}+\frac{1}{3}-\frac{1}{6}} \div \frac{17}{15}$$

$$= \frac{\frac{6+4-3}{12}}{\frac{126+90-70}{315}} \div \frac{34}{45}$$

$$= \frac{7}{12} \times \frac{315}{146} \times \frac{45}{34}$$

$$= \frac{1575}{1632}$$

$$= 1\frac{\cdot 943}{\cdot 1632}. \text{ Ans.}$$

2. Give a rule for finding the decimal point in dividing one decimal by another. Divide ·378 by 262·5, and 37·8 by ·0002625.

Rule: Subtract the number of decimal places in the divisor from the number in the dividend, and mark off the difference in the quotient. If the number in the divisor exceeds the number in the dividend add 0's till they are equal, and then subtract.

262·5)·378000(·00144. Ans.
2625
11550
10500
10500
10500

·0002625)37·8000000(144000. Ans.
2625
11550
10500
10500
10500
000

3. What decimal of a guinea is equal ·36 of 13s. 8½d.?

·36 of 13s. 8½d.
1 guinea

$$= \frac{36}{100} \times \frac{8\frac{1}{2}}{1} \times \frac{12}{504}$$

$$= \frac{1}{100} \times \frac{17}{2} \times \frac{1}{42}$$

$$= \frac{17}{8400}$$

$$= \cdot 2\frac{17}{21}. \text{ Ans.}$$

4. A boy loses ⅖ of his money and then gains 6d.; he then loses ⅓ of what he has and gains 4d.; he afterwards loses ¼ of what he has, and he finds he has 2s. 1d. left. How much had he at first?

2s. 1d. = ¼ of money before last loss.

∴ ¼ = $\frac{25 \times 8}{5}$ = 40d.

40d. = 4d. + ⅔ of money before second loss.

∴ ⅔ = $\frac{36 \times 3}{2}$ = 54d.

54d. = 6d. + ⅗ of money before first loss.

∴ ⅗ = $\frac{48 \times 4}{3}$ = 64d.

∴ 5s. 4d. = Money at first. Ans.

FEMALES.

1. Find the cost of 796 articles at £13 14s. 3½d. each.

	£	s.	d.			
10s. = ½ of a £	796	0	0	= Value of 796 arts. at £1 each.		
	13					
	10348	0	0	= ,, ,,	at £13 each	
4s. = ⅕ of a £	398	0	0	= ,, ,,	,, 10s. ,,	
3d. = 1/80 of 4s.	159	4	0	= ,, ,,	,, 4s. ,,	
½d. = ⅙ of 3d.	9	19	0	= ,, ,,	,, 3d. ,,	
	1	13	2	= ,, ,,	,, ½d. ,,	
	£10916	16	2	= £13 14s. 3½d. Ans.		

2. How much must be given for 84 cwt. 3 qrs. 14 lbs. at £12 11s. 8d. per cwt.?

	£	s.	d.		
2 qrs. = ½ of 1 cwt.	12	11	8	= Value of 1 cwt.	
	84				
	1057	0	0	= ,,	84 cwt.
1 qr. = ¼ of 2 qrs.	6	5	10	= ,,	2 qrs.
14 lbs. = ¼ of 1 qr.	3	2	11	= ,,	1 qr.
	1	11	5½	= ,,	14 lbs.
	£1068	0	2½	= 84 cwt. 3 qrs. 14 lbs. Ans.	

3. What is the least number of soldiers that can be divided into companies of 16, 30, 48, 56, and 72?

6 | 16, 30, 48, 56, 72
4 | 5, 8, 56, 12
5 14 3

6 × 4 × 5 × 14 × 3 = 5040. Ans.

4. How much change shall I have out of a £10 note after paying the following bill?

15¼ yards flannel at 2s. 3d. per yd.
29 yds. calico at 8½d. per yd.
25 yds. Irish linen at 2s. 4d. per yd.
17 yds. towelling at 1s. 2d. per yd.
12½ yds. brown holland at 11½d. per yd.
3½ doz. handkerchiefs at 9s. 10d. a doz.

		£	s.	d.
15¼ yds. flannel at 2s. 3d.	... per yd. =	1	14	10½
29 yds. calico at 8½d. ...	... ,, =	1	0	6½
25 yds. Irish linen at 2s. 4d.	... ,, =	2	18	4
17 yds. towelling at 1s. 2d.	... ,, =	0	19	10
12½ yds. brown holland at 11½d.	... ,, =	0	11	11¾
3½ doz. handkerchiefs at 9s. 10d. per doz.	=	1	14	5
		£8	19	11¾

£10 − £8 19s. 11¾d. = £1 0s. 0¼d. Ans.

Grammar.

MALES AND FEMALES.

1. Parse the sentence—

He needs strong arms who swims against the tide.

He—pers. pro., masc. gen., sing. no., 3rd per., nom. to *needs*.
needs—reg. trans. verb, act. voice, ind. mood, pres. tense, 3rd per., sing. no., agreeing with its nom. *he*.
strong—adj. of quality, qualifying *arms*.
arms—com. noun neut. gen., plur. no., obj. case, gov. by *needs*.
who—rel. pro., masc. gen., sing. no., 3rd per., agreeing with antecedent *he* and nom. to *swims*.
swims—irreg. intrans. verb, act. voice, ind. mood, pres. tense, 3rd per., sing. no., agreeing with its nom. *who*.
against—preposition, showing reln. bet. *tide* and *swims*.
the—dist. adj., limiting *tide*.
tide—com. noun, neut. gen., sing. no., obj. case, gov. by *against*.

2. Say how many sentences there are in this verse, and what is the subject and predicate of each—

Sweet bird! thy bower is ever green,
Thy sky is ever clear;
Thou hast no sorrow in thy song,
No winter in thy year.

Four.

Subject.	*Predicate.*
(1) Thy bower	is green
(2) Thy sky	is clear
(3) Thou	hast
(4) [Thou]	[hast]

3. Explain what is meant by a participle, and give examples.

A participle is that part of a verb which partakes of the nature of a verb and an adjective. Examples.—

Verb.	*Adjective.*
The sun is *shining*	The *shining* sun
The general was *defeated*	The *defeated* general

4. Show the meaning of the final syllable in each of the following words, and give other examples of words of the same formation:—

Oxen. Golden. Darken. Bounden. Duckling. Streamlet. Readable. Singer. Peaceful. Faithless.

Word.	Syllable	Meaning.	Other Words.
Oxen	en	Plural ending	Brethren, children: O.E., een (eyes) been (bees)
Golden	en	made of	wooden, flaxen, linen
Darken	en	to make (sign of Infinitive)	gladden, hearken
Bounden	en	to make (participial form)	molten, drunken
Duckling	ling	little (a diminutive)	gosling, darling, foundling
Streamlet	let	little	rivulet, leaflet, brooklet
Readable	ble	that which may be	eatable, drinkable, bearable
Singer	er	the person who acts	player, reader, painter
Peaceful	ful	full of	sorrowful, mournful, awful
Faithless	less	without	houseless, homeless, breathless

Geography.

(*Answer either Q. 1 or Q. 2; not both.*)

1. Draw a map of the West Coast of Scotland from Ardnamurchan Point to the Firth of Clyde, with the names of the islands and inlets.

2. Give an account of the mountain system of Ireland.

The mountains of Ireland consist of isolated ranges near the coast, forming a broken circle round the island, and enclosing the great central plain.

None of the mountains rise to a great height, Carran Tual (3,404 ft.) in Macgillicuddy's Reeks, Kerry, being the highest.

The chief ranges are the Mourne Mountains in Down, the Mountains of Antrim, Donegal, and Mayo; the Connemara Mountains, stretching from Clew Bay to Galway Bay; Clare Mountains; Mount Brandon, near Tralee Bay; Macgillicuddy's Reeks in Kerry; Galtee Mountains, and Knockmeledown Mountains in Tipperary and Waterford, and the Wicklow Mountains. There is one range in the interior, the Slieve Bloom Mountains, which separates the basin of the Levem from that of the Barrow and Suir. The hills are cultivated often to the summit.

3. Describe the rivers of Australia.

Australia has fewer rivers than either of the other continents, and of those which are known, only the Murray is navigable to any great extent. Parallel with the eastern coast runs a range of mountains known by different names. This range is the source of the Murray, which flows in a south-westerly direction, with many windings, for nearly 2,000 miles, entering the sea at Encounter Bay, in South Australia. Its tributaries are the Lachlan, Darling, and Murrumbidgee.

The interior of Australia, so far as is known, is entirely destitute of streams, and the only other rivers are the Hunter, in New South Wales; the Brisbane, in Queensland; the Albert, flowing into the Gulf of Carpentaria; the Adelaide, into Van Diemen's Gulf; and the Swan River in Western Australia.

History.

1. 'The true conqueror of Britain was Julius Agricola.' Explain this statement, and tell the limits of his sway in the British Islands.

Although a great part of England had been subdued between 43 and 78 A.D., the people were not actually conquered, and no sooner were the Roman forces removed than the Britons resumed their sway. When Julius Agricola came as Governor, he not only conquered the country, but by his clemency he caused the people to like the Romans. He encouraged them to build temples, courts of justice, and better houses for themselves, to wear the Roman dress, and adopt the ways and manners of the Romans. In this way he may be said to have been the real conqueror of Britain. He reconquered Anglesea, and extended his sway during the seven years he was Governor throughout the whole of the North of England and the South of Scotland to the Forth and Clyde, in one campaign going even to the Grampians. He built two lines of forts, from the Tyne to the Solway, and from the Forth to the Clyde. His ships also circumnavigated the island.

2. What parts of this country were settled by the Jutes, Angles, and Saxons respectively? Name some of the kingdoms set up by them.

The *Jutes* were the first Teuton invaders of England. They came in 450 on the invitation of Vortigern, who gave them the Isle of Thanet. After quarrels and wars with the Britons they founded the *Kingdom of Kent*.

The second settlement (477) was made by the *Saxons*, under Ella, in Sussex, and afterwards Surrey. This was known as the Kingdom of the *South Saxons*.

The *West Saxon* Kingdom (Wessex) included Hampshire and Dorsetshire, and was formed by Cerdic and his sons (495-514).

Another body of Saxons occupied Middlesex and Essex in 527. They were the East Saxons.

The Kingdom of *East Angtia* was founded by the Angles in the sixth century. It included Norfolk, Suffolk, Cambridge, and Huntingdon. The Angles also founded Northumbria in 617.

Mercia was founded by the Angles, under Cridda, in 582.

3. Who was Earl Godwin? Which of our kings was he connected with?

Earl Godwin was an Englishman whom Canute placed over Wessex, one of the five earldoms into which he divided the country, and to whom he gave Gytha, a Danish lady belonging to the family of Canute, in marriage.

Godwin assisted *Harold*, and afterwards *Hardicanute*, to the throne of England. His daughter Edith subsequently married *Edward the Confessor*. His son *Harold* was, on the death of Edward, chosen as the king of England.

Composition.

Write from memory the substance of the passage read to you by the Inspector.

The passage was as follows:—

In Sierra Leone, on occasion of a violent tropical storm, two native people, a man and a woman, were engaged at the door of their hut, singing, beating drums, and offering up their adorations and prayers to the lightning. Suddenly a loud shriek took the place of the votive song. The hut of the miserable pair was struck by the fluid which they were worshipping, and they were buried in the ruins. Next day they were found, blackened, distorted, and putrefying, by the officers of an English expedition who had witnessed the catastrophe. But it appeared that the countrymen of the victims regarded their death as an especial mark of the favour of their gods, who had translated them to heaven by the agency of the sacred fluid, the object of their worship.

FEMALES.

Needlework.

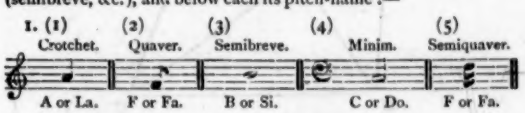
One hour will be allowed for this exercise in the afternoon.

Music.

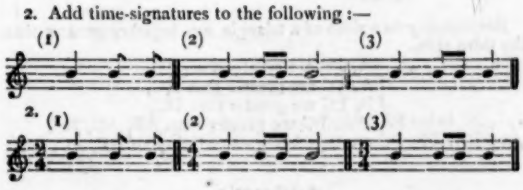
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

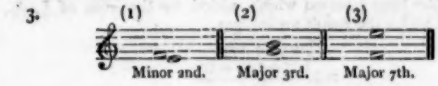
1. Write above each of the following notes its value-name (semibreve, &c.), and below each its pitch-name:—



2. Add time-signatures to the following:—

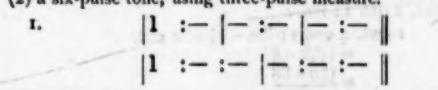


3. Write below each of the following intervals its name (major fourth, &c.):—



TONIC SOL-FA NOTATION.

1. Write (1) a six-pulse tone, using two-pulse measure; and (2) a six-pulse tone, using three-pulse measure.



2. Write the names of the following intervals:—(1) *me* to *fah*; (2) *soh* to *te*; (3) *fah* to *me*'.

2. (1) Minor second; (2) major third; (3) major seventh.

3. Write the following an octave higher, and state what is meant by the direction "Key G":—

Key G.

	|d	:s	|n	:f	|s	:l	|r'	:s	|n'	:— ‖
3.	|d'	:s'	|n'	:f'	|s'	:l'	|r''	:s'	|n''	:— ‖

"Key G" means that *doh* is to be fixed to the sound of the scale called G.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

1. If two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise their bases equal; the angle which is contained by the two sides of the one shall be equal to the angle contained by the two sides equal to them of the other.

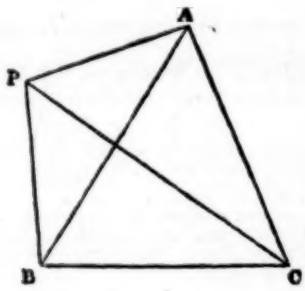
Euclid, Book I., Prop. 8.

2. To make a triangle of which the sides shall be equal to three given straight lines, but any two whatever of these must be greater than the third.

Euclid, Book I., Prop. 22.

3. P is a given point, ABC a given triangle; show that the sum of PA, PB, PC is greater than half the sum of the sides.

Let P be the given point, and ABC the given triangle. Join PA, PB, and PC.



Because any two sides of a triangle are together greater than the third side,

∴ PA, PB are greater than AB,
PA, PC are greater than AC,
PB, PC are greater than BC,

∴ twice PA, PB, PC are greater than AB, AC, BC,
and PA, PB, PC are together greater than half AB, AC, BC.
Q.E.D.

Arithmetic.

FEMALES.

1. Find the least fraction which added to the sum of $\frac{7}{9}$, $\frac{8}{15}$, and $\frac{5}{12}$ will make the result an integer.

$$\frac{7}{9}+\frac{8}{15}+2\frac{5}{12}$$
$$=2\frac{105+108+50}{120}$$
$$=4\frac{43}{120}$$
∴ Least fraction $=5-4\frac{43}{120}=\underline{\frac{77}{120}}$. Ans.

2. What fraction of a ton added to $\frac{1}{11}$ of 2 cwt. will make it equal to 1 cwt. 2 qrs. 11 lbs.?

1 cwt. 2 qrs. 11 lbs. $-\frac{1}{11}$ of 2 cwt.
$$=1\frac{31}{112}-\frac{1}{11}$$
$$=\frac{179-88}{112}$$
$$=\frac{91}{112}\text{ cwt.}$$
$$=\underline{\frac{13}{112}\text{ ton.}}\text{ Ans.}$$

3. Express as decimal fractions $\frac{27}{200}$ and $\frac{13}{150}$.

$\frac{27}{200}=\frac{135}{1000}=\underline{.135}$. Ans.

$\frac{13}{150}=\frac{1}{10}=\underline{.1}$. Ans.

4. Out of a cask two-thirds full eight gallons are drawn, and it is then found to be two gallons less than half full. How many gallons is the cask able to hold?

$\frac{2}{3}-\frac{1}{2}=\frac{1}{6}$.
$\frac{1}{6}$ of the cask holds 6 gallons.
∴ The cask holds $6\times6=\underline{36\text{ gallons}}$. Ans.

Grammar.

MALES AND FEMALES.

1. Show how many separate sentences there are in the following extract, and what are the parts of each:—

O dread and silent mount! I gazed upon thee
Till thou, still present to the bodily sense,
Didst vanish from my thought: Entranced in prayer
I worshipped the Invisible alone.

—COLERIDGE.

ANALYSIS.

Sentence.	Kind of Sentence.	Conn.	Subject.	Predicate.	Object.	Exten.
(*a*)						
I gazed upon thee	Principal Sentence.		I	gazed		upon thee (place)
(*b*)						
till thou, still present to the bodily sense, didst vanish from my thoughts.	Adv. Sent. (time) to *a*.	till	thou still present to the bodily sense	didst vanish		from my thought (place)
(*c*)						
Entranced in prayer I worshipped the Invisible alone	Principal Sentence.		I, entranced in prayer,	worshipped	the Invisible alone	

2. How would you explain and illustrate to a class the meaning and use of each of the following grammatical terms:—

Relative. Imperative. Potential. Passive. Intransitive. Irregular.

Relative.—Pronouns are called *Relative* when they refer to, and stand for, some noun or pronoun which has been used before, such noun or pronoun being called the *Antecedent.* Illustration: The boys were talking of the holiday *which* had been promised them. Here *which* stands for holiday, and reference must be made to *holiday* in order to determine what *which* means.

Imperative.—A word used to describe the form of the verb which is used when a command is given; as: *Go* home. When used thus, *go* expresses a command, and the verb is said to be in the Imperative Mood.

Potential.—A mood of verbs expressing power, permission, will, or necessity, as: I *may* go; I *can* ride; I *must* walk.

Passive.—When the form of the verb signifies that the person or thing spoken of (the nominative case) does not act, but is acted upon, the verb is said to be in the Passive Voice, as, The house *was built.*

Intransitive.—Some verbs are complete in themselves, and do not need an object to be stated to complete the the sense. Such verbs are called *Intransitive.* Ex. Birds *fly.* Lions *roar.*

Irregular.—Many verbs form their past tense and past participle in one regular way, by adding *d* or *ed* to the present tense. Those which do not are called *Irregular* verbs, as, Sing, sang, sung.

3. Make a list of five words commencing with each of the following syllables, and explain the meaning of each word, showing the full force of the prefix:—

e. con. a. ob. re. inter.

e:—*educe*, to lead or draw *out*; *evade*, to go *away* or escape *from*; *elapse*, to slip or glide *away from*; *elect*, to choose *out*; *emit*, to send *out.*

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SECOND PAPER.

Two hours and a half allowed.

FEMALES.

Needlework.

The needlework specimens will be collected by the Inspector at the expiration of an hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. A man walks 10 miles in 3 hours, then 12 miles in 3½ hours, and then 13 miles in 4 hours. What is his average rate of walking per hour?

Total miles walked = 10 + 12 + 13 = 35 miles.
" hours " = 3 + 3½ + 4 = 10½ hrs.
No. miles walked per hour = 35 ÷ 10½ = 3⅓. Ans.

2. In what time will £875 12s. 6d. amount to £1,013 10s. 8½d. at 4½ per cent. per annum simple interest?

	£	s.	d.	£	s.	d.	£	s.	d.
Total interest =	1013	10	8½	− 875	12	6	= 137	18	2½.

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3. If by investing £2,145 in 5 per cent. railway debentures I get £82 10s. in dividend, what must be the price of the debentures, the usual brokerage being charged?

If the price per cent. were £100, the yield would be

$$\frac{2145 \times 5}{100} = £107\ 5s.$$

£	s.		£	s.		£		£
∴ 82	10	:	107	5	::	100	:	130

130 − ½ = 120½. Ans.

4. If a woman buys eggs at 10d. a dozen, how many ought she to sell for 9d. in order to gain 8 per cent.?

Price per dozen to gain 8 per cent. =

d.		d.		d.
100	:	108	::	10 : $10\frac{8}{10}$

No. to be sold for 9d. to gain 8 per cent. =

d.		d.		eggs		eggs
$10\frac{8}{10}$	:	9	::	12	:	10. Ans.

History.

MALES.

1. What change of language and law followed the Norman Conquest?

French was the language of the Normans. When England was conquered by William, French became the language of the court, of the nobility (both French and English), and of the inferior clergy. Any literature that existed was written in French. French was spoken in the courts of law, in the universities, in parliament, and all the schools attached to the cathedrals and churches, and many of the country people spoke French in order that they might be the more thought of.

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The Channel or Norman Isles were part of the duchy, and have been retained by this country since the Conquest.

3. When and where did John die? Describe the condition of the country at that time.

John died on the 19th of October, 1216, in the Castle of Newark, after his jewels and treasures had been lost while crossing the Wash.

The country at the time of his death was in a state of insurrection. He had violated the Charter which he had sworn to keep, by obtaining a papal bull annulling it, and by over-running the country with a band of mercenaries. The barons threw off their allegiance and offered the crown to Louis, the son of the King of France. Louis came to London and received their homage. John collected his forces in Lincolnshire, while Louis besieged Dover.

This was the state of affairs when the accident happened which resulted in John's death.

3. Write the following an octave higher, and state what is meant by the direction "Key G":—

Key G.

d	:s	|m	:f	|s	:l	|r	:s |m :— ‖
3. d'	:s'	|m'	:f'	|s'	:l'	|r'	:s' |m' :— ‖

"Key G" means that *doh* is to be fixed to the sound of the scale called G.

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used.]

1. If two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise their bases equal; the angle which is contained by the two sides of the one shall be equal to the angle contained by the two sides equal to them of the other.

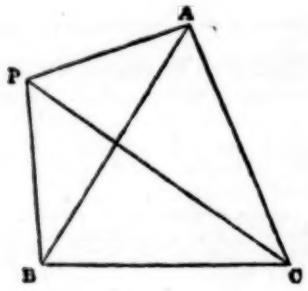
Euclid, Book I., Prop. 8.

2. To make a triangle of which the sides shall be equal to three given straight lines, but any two whatever of these must be greater than the third.

Euclid, Book I., Prop. 22.

3. P is a given point, ABC a given triangle; show that the sum of PA, PB, PC is greater than half the sum of the sides.

Let P be the given point, and ABC the given triangle. Join PA, PB, and PC.



Because any two sides of a triangle are together greater than the third side,

∴ PA, PB are greater than AB,
PA, PC are greater than AC,
PB, PC are greater than BC,

∴ twice PA, PB, PC are greater than AB, AC, BC,
and PA, PB, PC are together greater than half AB, AC, BC.

Q.E.D.

Arithmetic.

FEMALES.

1. Find the least fraction which added to the sum of $\frac{1}{6}$, $\frac{5}{12}$, and $\frac{2}{3}\frac{1}{6}$ will make the result an integer.

$$\frac{1}{6}+\frac{5}{12}+2\frac{1}{3}\frac{1}{6}$$
$$=2\frac{105+108+50}{120}$$
$$=4\frac{3}{1}\frac{3}{2}\frac{3}{0}$$

∴ Least fraction $=5-4\frac{3}{1}\frac{3}{2}\frac{3}{0}=\underline{\frac{2}{1}\frac{7}{2}\frac{7}{0}}$. Ans.

2. What fraction of a ton added to $\frac{1}{1}\frac{1}{2}$ of 2 cwt. will make it equal to 1 cwt. 2 qrs. 11 lbs.?

1 cwt. 2 qrs. 11 lbs. $-\frac{1}{1}\frac{1}{2}$ of 2 cwt.
$$=1\frac{2}{1}\frac{7}{2}\frac{7}{0}-\frac{1}{1}\frac{1}{2}$$
$$=\frac{179-88}{112}$$
$$=\frac{9}{1}\frac{1}{1}\frac{1}{2} \text{ cwt.}$$
$$=\underline{\frac{1}{1}\frac{3}{2}\frac{3}{0}} \text{ ton.}$$ Ans.

3. Express as decimal fractions $\frac{3}{1}\frac{7}{0}\frac{7}{0}$ and $\frac{1}{1}\frac{3}{2}\frac{5}{0}$.

$\frac{3}{1}\frac{7}{0}\frac{7}{0}=\frac{135}{1000}=\underline{\cdot 135}$. Ans.

$\frac{1}{1}\frac{3}{2}\frac{5}{0}=\frac{1}{10}=\underline{\cdot 1}$. Ans.

4. Out of a cask two-thirds full eight gallons are drawn, and it is then found to be two gallons less than half full. How many gallons is the cask able to hold?

$\frac{2}{3}-\frac{1}{2}=\frac{1}{6}$.

$\frac{1}{6}$ of the cask holds 6 gallons.

∴ The cask holds $6\times 6=\underline{36 \text{ gallons}}$. Ans.

Grammar.

MALES AND FEMALES.

1. Show how many separate sentences there are in the following extract, and what are the parts of each:—

O dread and silent mount! I gazed upon thee
Till thou, still present to the bodily sense,
Didst vanish from my thought: Entranced in prayer
I worshipped the Invisible alone.

—COLERIDGE.

ANALYSIS.

Sentence.	Kind of Sentence.	Conn.	Subject	Predicate.	Object.	Exten.
(*a*)						
I gazed upon thee	Principal Sentence.		I	gazed		upon thee (place)
(*b*)						
till thou, still present to the bodily sense, didst vanish from my thoughts.	Adv. Sent. (time) to *a*.	till	thou still present to the bodily sense	didst vanish		from my thought (place)
(*c*)						
Entranced in prayer I worshipped the Invisible alone	Principal Sentence.		I, entranced in prayer,	worshipped	the Invisible alone	

2. How would you explain and illustrate to a class the meaning and use of each of the following grammatical terms:—

Relative. Imperative. Potential. Passive. Intransitive. Irregular.

Relative.—Pronouns are called *Relative* when they refer to, and stand for, some noun or pronoun which has been used before, such noun or pronoun being called the *Antecedent.* Illustration: The boys were talking of the holiday *which* had been promised them. Here *which* stands for holiday, and reference must be made to *holiday* in order to determine what *which* means.

Imperative.—A word used to describe the form of the verb which is used when a command is given; as: *Go* home. When used thus, *go* expresses a command, and the verb is said to be in the Imperative Mood.

Potential.—A mood of verbs expressing power, permission, will, or necessity, as: I *may* go; I *can* ride; I *must* walk.

Passive.—When the form of the verb signifies that the person or thing spoken of (the nominative case) does not act, but is acted upon, the verb is said to be in the Passive Voice, as, The house *was built.*

Intransitive.—Some verbs are complete in themselves, and do not need an object to be stated to complete the the sense. Such verbs are called *Intransitive.* Ex. Birds *fly.* Lions *roar.*

Irregular.—Many verbs form their past tense and past participle in one regular way, by adding *d* or *ed* to the present tense. Those which do not are called *Irregular* verbs, as, Sing, sang, sung.

3. Make a list of five words commencing with each of the following syllables, and explain the meaning of each word, showing the full force of the prefix:—

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100	:	108	::	10 : $10\frac{8}{25}$

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Teaching.

Give some examples of different kinds of mental exercise in arithmetic suited for children in the Second Standard.

Examples in the simple rules, separate and combined :—

$7+4+9+20$; $9+5+4+12$;
$17-10+7-4$; $15+5+20-30$;
$9\times8+4$; $11\times11-1$; $10\times12+16$;
$36\div4\times9$; $72\times2\div12$.

In Money :—

Pence in 4s. ; 5s. ; 6s. ; 8s. ; 10s. ; 12s.
,, 3s. 6d. ; 4s. 2d. ; 5s. 7d. ; 8s. 1d. ; 9s. 2d.
Farthings in 4½d. ; 5¾d. ; 8¼d. ; 1s. 0¾d.
,, 1s. ; 1s. 6d. ; 2s. ; 2s. 6d.

A boy steps 18 inches at a time; how many in 5 steps?
A chicken costs 10d. ; how many shillings for 6 chickens?
Five pairs of boots cost 50s. ; what will one pair cost?
Two? Three? Four?
Add 4¼d. and 5½d. ; take 7½d. from 1s. ; 11½d. from 1s. 1d.

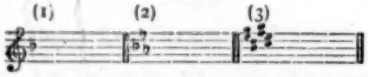
Music.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write the key-signature of each of the following major keys :—(1) of F ; (2) of E♭ ; (3) of E.

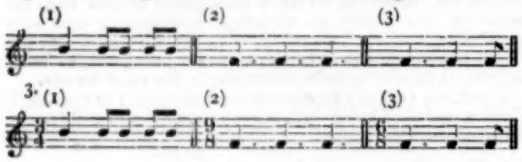
1. (1) (2) (3)



2. Write below each of the following intervals its name (major second, &c.) :—

2. (1) (2) (3).

3. Add time-signatures to each of the following :—



TONIC SOL-FA NOTATION.

1. Write the names of the following intervals :—(1) *lah* to *me*; (2) *doh'* to *fah* ; (3) *te* to *fah* ; (4) *fah* to *te*$_1$.

1. (1) Perfect or major fourth ; (2) perfect or major fifth ; (3) pluperfect or augmented fourth ; (4) minor or diminished fifth.

2. What is the mental effect of (1) *fah* ; (2) *me* ; (3) *lah*?

2. (1) Serious, grave, expectant ; (2) calm and peaceful; (3) sad.

3. What are the five kinds of measure most commonly used?

3. Two, three, four, six, and nine-pulse.

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

All generally understood abbreviations for *words* may be used.]

Answer two Questions, including No. 3, if you can.

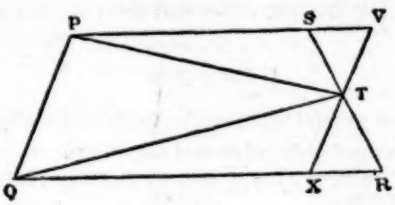
1. If two triangles have two sides of the one equal to two sides of the other, each to each, but the angle contained by the two sides of one of them greater than the angle contained by the two sides equal to them, of the other; the base of that which has the greater angle shall be greater than the base of the other.

Euclid : Book I., Prop. 24.

2. If the square described upon one of the sides of a triangle, be equal to the squares described upon the other two sides of it ; the angle contained by these two sides is a right angle.

Euclid : Book I., Prop. 47.

3. PQRS is a quadrilateral having QR parallel to PS, T is the middle point of SR ; show that the triangle PQT is half the quadrilateral.



Let PQRS be the given quadrilateral, and T the middle point of RS.

Through T draw XV parallel to PQ and meeting PS in V.

Then $\angle VST = \angle TRX$ (I. 29) ; $\angle STV = \angle XTR$ (I. 15), and side ST = side TR, $\therefore$ $\triangle STV = \triangle TXR$ (I. 26).

Add to each PQXS. Then quadrilateral PQRS = parallelogram PQXV, and $\triangle$ PQT = half parallelogram PQXV, because they are upon the same base PQ and between the same parallels PQ and XV.

$\therefore$ $\triangle$ PQT = half the quadrilateral PQRS.

Q. E. D.

Algebra.

(Answer two Questions, including No. 2, if you can.)

1. Simplify $9(3x-a)(3x+a)-7(2x+a)^2+3(2x-3a)(x+4a)$

$9(3x-a)(3x+a)-7(2x+a)^2+3(2x-3a)(x+4a)$
$=9(9x^2-a^2)-7(4x^2+4xa+a^2)+3(2x^2+5xa-12a^2)$
$=81x^2-9a^2-28x^2-28xa-7a^2+6x^2+15xa-36a^2$
$=59x^2-13xa-52a^2$. Ans.

2. Prove the rule for finding the L. C. M. of two expressions.

Find it for x^3-4, x^3+8, $2x^2+3x-2$, and $2x^3-3x-2$.

Let A and B denote two expressions, and C their common measure. Let $A=pC$ and $B=qC$. Then since C = the G. C. M. of pC and qC, p and q have no common factor, and the least number which will contain p and q, that is, their least common multiple, is pq. $\therefore$ the least common multiple of pC and qC is pqC.

And $pqC = Aq = Bp = \frac{AB}{C}$

$x+2 \mid x^3-4,\ x^3+8,\quad 2x^2+3x-2,\ 2x^2-3x-2$
$x-2 \mid x-2,\ x^2-2x+4,\ 2x-1,\quad 2x^2-3x-2$
$\qquad\quad x^2-2x+4,\ 2x-1,\quad 2x+1$

L. C. M. = $(x^3-4)(x^2-2x+4)(4x^2-1)$. Ans.

3. Solve the equations :—

(1) $\frac{2x-\frac{1}{2}}{2}-\frac{2x-\frac{1}{5}}{5}=\frac{4x}{13}$

(2) $\frac{x-1}{x+3}-\frac{2x-1}{3x+1}=\frac{1}{5}$

(1) $\frac{2x-\frac{1}{2}}{2}-\frac{2x-\frac{1}{5}}{5}=\frac{4x}{13}$

$130x-32\frac{1}{2}-52x+39=40x$

$38x=162\frac{1}{2}-39$

$38x=123\frac{1}{2}$

$x=3\frac{1}{4}$. Ans.

(2) $\frac{x-1}{x+3}-\frac{2x-1}{3x+1}=\frac{1}{5}$

$$3(3x^2-2x-1)-3(2x^2+5x-3)=3x^2+10x+3$$
$$9x^2-6x-3-6x^2-15x+9=3x^2+10x+3$$
$$-31x=-3$$
$$x=\frac{3}{31}. \quad \text{Ans.}$$

Mensuration.

A room is 15 feet long, 10 broad, and 9¾ high. Find the cost of painting the walls and the ceiling at 1s. 9d. per sq. yd.

Length of walls $=(15+10)2=50$ feet
Area of walls $=50\times 9\frac{3}{4}=487\frac{1}{2}$ sq. feet
,, ceiling $=10\times 15=150$ sq. ft.
Total area $=(487\frac{1}{2}+150)=637\frac{1}{2}$ ft. $=70$ sq. yd. $7\frac{1}{2}$ ft.
Cost $=$ 1s. 9d. $\times 70\frac{5}{8}=$ £6 3s. 11½d. Ans.

Arithmetic.

FEMALES.

Add together £·0375, ·625s., ·75d., and 3s. 3·5d., and reduce the sum to the decimal of 7s. 6d.

	s.	d.
£·0375 = ·75s.	= 0	9
·625s.	= 7·5d. = 0	7½
·75d.	= 3f. = 0	¾
3s. 3·5d.	= 3	3½
	4	8¾

$$\frac{4\text{s. } 8\frac{3}{4}\text{d.}}{7\text{s. } 6\text{d.}}=\frac{233}{360}=\cdot 630\dot{5}. \quad \text{Ans.}$$

2. The circumference of a circle is 3·14159 times its diameter; find the length of the diameter of a circle whose circumference is 13 yds. 2 ft. 7¾ in. (Work to 4 places of decimals only.)

yds.	ft.	in.
13	2	7¾
	3	
	41	
	12	
		in.

3·14159)499·75(159·0754+
=4 yds. 1 ft. 3·0754+ins. Ans.

3. A bankrupt having £645 5s. 3½d. left, can pay 7s. 8½d. in the £; what is the amount of his debts?

s.	d.	£	s.	d.	£		£	s.	d.
7	8½	: 645	5	3½	:: 1	:	1674	4	0. Ans.

4. Simplify $\frac{(3\cdot 2-2\cdot 9)\times 147}{\cdot 003\times \cdot 0005}$.

$$\frac{(3\cdot 2-2\cdot 9)\times 147}{\cdot 003\times \cdot 0005}$$
$$=\frac{\cdot 3\times 147}{\cdot 003\times \cdot 0005}$$
$$=\frac{100\times 147}{\cdot 0005}$$
$$=\frac{20\times 147}{\cdot 0001}$$
$$=200000\times 147$$
$$=29{,}400{,}000. \quad \text{Ans.}$$

Grammar.

MALES AND FEMALES.

Analyse this sentence:—

'If a man be bird-witted, that is, quickly carried away, and hath not the patient faculty of attention, let him study the mathematics; wherein, if the wit wander, the demonstration must be renewed.'

BACON.

ANALYSIS.

Sentence.	Kind of Sentence.	Connective.	Subject.	Predicate.	Object.	Extension of Pred.
(a) If a man be bird-witted	Adv. (cond.) to *e*	If	a man	be bird-witted		
(b) that is	Princ. sent.		that	is		
(c) quickly carried away	Adv. (cond.) to *e*	*if*	[a man]	[be] carried		quickly away
(d) and hath not the patient faculty of attention	Adv. (cond.) to *e*	*if*	[a man]	hath	the patient faculty of attention	not
(e) let him study the mathematics	Princ. sent.		[thou]	let	him [to] study the mathematics	
(f) wherein the demonstration must be renewed	Adj. sent. to mathematics in *e*	where in	the demonstration	must be renewed		
(g) if the wit wander	Adv. (cond.) to *f*	if	the wit	wander		

2. Explain in your own words the meaning of the above passage.

The best remedy for a man who finds it difficult to fix his attention fully upon the matter he has in hand, who finds that whenever he commences to work his mind begins to wander first to one thing and then another, like a bird flies from branch to branch, is to apply himself to that branch of science called Mathematics, because in it he will find that if he does not pay the strictest heed he will be compelled to begin the work anew, and to do it over and over again.

3. Show what is the precise meaning of the prefix in each of the following words. Say from what language it is derived, and give in each case another word similarly formed:—

Improper, Impose, Amphibious, Unclean, Recover, Reform, Conceal, Contradict, Behave, Sympathy, Antedate, Antithesis.

Word.	Prefix.	Meaning.	Source.	Other Word.
Improper	im-	not	Latin	improbable
Impose	im-	upon	,,	imprecate
Amphibious	amphi-	both	Greek	amphitheatre
Unclean	un-	not	Saxon	unkind
Recover	re-	back	Latin	remove
Reform	re-	again	,,	receive
Conceal	con-	altogether, or completeness	,,	concave
Contradict	contra-	against	,,	contravene
Behave	be-	sign of infinitive	Saxon	behead
Sympathy	sym-	with	Greek	symmetry
Antedate	ante-	before	Latin	antemeridian
Antithesis	anti-	against	Greek	anti-climax

4. 'What' is said to be a compound relative. Explain this, and give four or five examples of sentences in which the word occurs, and in which its case would require to be specially made plain to a class of learners.

A relative pronoun stands for a noun or pronoun which has gone before it, and generally connects a subordinate sentence to a principal sentence. Sometimes, however, the noun is not stated, but is understood as being contained in the word *what*. It is in this way that 'what' is called a compound relative, because it stands for the antecedent and for the relative as well.

Examples requiring explanation :—

I have what I require.
This is what he wants.
He hath well-fortified what he hath won.
Tell me what they seek.
What is one man's meat is another man's poison.

Geography.

1. Draw a map of the Coast of Africa from the Orange River to the mouth of the Zambesi.

2. What are Constant, Periodical, and Variable Winds? Give examples of each.

Constant Winds are such as constantly blow in the same direction. The Trade Winds and the Polar Winds are examples.

Periodical Winds are those which blow for certain periods of the year, or at certain times and seasons, as, the Monsoons, and the Land and Sea Breezes.

Variable Winds are those which blow at no fixed period. Variable Winds are common in all temperate regions.

3. State the positions and give some account of the lakes of Asia.

The Caspian Sea (750 miles by 200 miles) and the Sea of Ural (265 miles by 125 miles) are great salt-water lakes of Asia lying to the South of the Ural Mountains, the Caspian Sea being much below the level of the ocean. They have no outlets.

The largest fresh-water lake of Asia is Lake Baikal, in the same latitude as England, and in longitude 104° to 111° E. It is 400 miles long, from 20 to 50 miles broad, and in many places very deep. It receives many streams, the Lelinga and the Angara being the largest.

There are several lakes in Western Asia, but they are not very large. Balkash, near the north of the great central depression of Asia, is 150 miles long and 75 broad, but has no outlet. Tehany, in Siberia; Urumiyah, in Persia; Van, in Armenia, are salt-water lakes. Pangong, in Thibet, and Sir-i-Kol are noted, the one for its connection with the Indus, and the other as being the highest known lake in the world.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a dealer by selling a horse for £34 4s. lost 5 per cent., what per cent. would he gain or lose by selling it for £39 12s.?

£34 4s. represents the value − 5 per cent.

$$= 100 - 5 = 95.$$

£ s. £ s. £ £

∴ 34 4 : 39 12 :: 95 : 110

Gain = 110 − 100 = 10 per cent. Ans.

2. Find, in decimals, the value of $\sqrt{1\frac{48}{121}} - \sqrt{\frac{1}{9}}$.

$$\sqrt{1\tfrac{48}{121}} - \sqrt{\tfrac{1}{9}}$$
$$= \sqrt{\tfrac{169}{121}} - \sqrt{\tfrac{1}{9}}$$
$$= \tfrac{13}{11} - \tfrac{1}{3}$$
$$= \frac{39 - 11}{33}$$
$$= \tfrac{28}{33}$$
$$= \underline{.84}. \text{ Ans.}$$

3. A person invested £5245 10s. in the 3 per cents. at 100½, and the stocks falling he sold out on the same day at par. How much did he lose, brokerage being charged on each transaction?

He paid $100\tfrac{1}{2} + \tfrac{1}{2} = 100\tfrac{1}{2}$

He sold for $100 - \tfrac{1}{2} = 99\tfrac{1}{2}$

∴ Loss on $100\tfrac{1}{2} = 1$

,, $5245\tfrac{1}{2} = \frac{1 \times 5245\tfrac{1}{2}}{100\tfrac{1}{2}} = \underline{£52}$. Ans.

4. The true present worth of a bill of £347 12s. 6d. due 8 months hence is £337 10s. Find the rate of interest per cent. per annum.

Total interest for 8 months =

£347 12s. 6d. − £337 10s. = £10 2s. 6d.

£ £ £ £

∴ $337\tfrac{1}{2}$: 100 :: $10\tfrac{1}{4}$: $\underline{4\tfrac{1}{2} \text{ per cent.}}$ Ans.

months 8 12

History.

MALES AND FEMALES.

1. Who were the Stuarts? What was their general attitude towards Parliament?

The Stuarts were the descendants of Henry VII., king of England, through his daughter Margaret. After the death of James IV. of Scotland, to whom she was married, Margaret married Archibald Douglas, by whom she had a daughter, Margaret, who married Matthew Stuart, Earl of Lennox. Lord Darnley, their son, married Mary, grand-daughter of James the Fourth, and their son, James the Sixth of Scotland, became James I. of England.

The general attitude of the House of Stuart was one of hostility to the Parliament. James I. and Charles I. were both strong advocates of the Divine right of kings. The Parliament represented the popular aspirations after freedom and liberty. The result was that the kings and Parliament were frequently in conflict, Charles I. being beheaded, and James II. being deposed.

2. What was Ship Money? Explain John Hampden's objection to pay it.

During the time of Elizabeth, the maritime counties had been called upon to furnish ships for the nation in time of war. When striving to carry on the Government without a Parliament, Charles bethought him of this method of raising money. He, therefore, first demanded ships, or *money in lieu of ships*, from the maritime counties. Not content with this, he levied this tax on all the shires. It derived its name, therefore, from the purpose for which it was sought.

John Hampden refused to pay his share of the tax, for although the sum was only small, yet on it depended the question whether the King or Parliament should be supreme in the country. If the King could take what money he pleased, and in what way he pleased, then he would soon be able to do whatever else he pleased. Hence his refusal.

3. What made the English under Queen Anne take part in the War of Spanish Succession? Mention three great battles in which they were victorious, and one where they were defeated.

William III. had entered into an alliance with Austria and Holland, just before his death, against Louis XIV. and his grandson. Louis claimed for his grandson the crown of Spain. The allies supported the claims of Archduke Charles of Austria. To enforce this claim and to humble Louis, the alliance declared war against France, soon after Anne ascended the throne, A.D. 1704.

Churchill, Duke of Marlborough, defeated Louis in the battles of Blenhiem (1704), Ramilies (1706), and Oudenarde (1708). But the allies were defeated at Almanza in 1707.

Teaching.

Write notes of a lesson on lakes and their formation.

Nature of Lakes.—The natural depressions of land filled with water from rivers, springs, or rains form lakes.

Varieties of Lakes.—Lakes may be divided according to the way in which they receive, or part with their water, *e.g.*, lakes which receive and give out waters; lakes which receive but do not give out waters, except by evaporation. Lakes may be also divided into salt and freshwater lakes, or into mountain lakes and lakes of the plains.

Illustrations of different kinds of Lakes.—Those which receive and give out waters are generally fed by the upper streams of a river, and are expansions of the bed of a river, *e.g.*, Lakes of the St. Lawrence in America; Victoria and Albert Nyanza, of the Nile.

Mountain Lakes belong to this class. The Swiss, Italian, and English lakes are of this class, and mountain lakes are generally noted for their great beauty and picturesqueness. Small mountain lakes are called *tarns*. The Caspian, Aral,

and Dead Seas are among those which receive, but do not give out waters. Evaporation must equal the supply. They are nearly always salt (Tchad is an exception).

Distribution of Lakes.—America has most. Africa the largest (Nyanza). Asia the highest (Sir-i-kol), and lowest (Dead Sea). Europe the most beautiful.

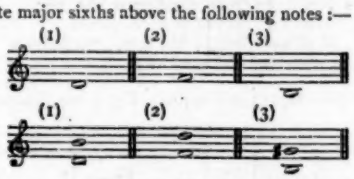
Uses of Lakes.—Regulate the discharge of rivers; expose a large surface to evaporation, and thus modify the climate, purify the rivers.

Music.

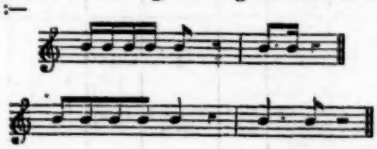
A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write major sixths above the following notes :—



2. Re-write the following, doubling the value of every note and rest :—



3. Explain (briefly) the following terms :—(1) M. 100; (2) *Dal Segno*; (3) *Staccato.*

3. (1) Metronome making 100 beats in a minute; (2) repeat from the sign 𝄋; (3) cut short, crisp.

TONIC SOL-FA NOTATION.

1. Write major sixths above the following notes :—(1) *ray*; (2) *fah*; (3) *te*$_1$.

1. (1) *te*; (2) *ray*^{1}; (3) *se*.

2. Re-write the following in four-pulse measure, doubling the value of each note and rest :—

2. | s ,l .s ,f :m . | s .,f :m ‖
2. | s .l :s .f | m : | s :- .f | m :— ‖

3. Explain (briefly) the following terms :—(1) M. 100; (2) *Dal Segno*; (3) *Staccato.*

3. Metronome making 100 beats in a minute; (2) repeat from the sign 𝄋; (3) cut short, crisp.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[All generally understood abbreviations for *words* may be used]

(*Answer two Questions, including No.* 3, *if you can.*)

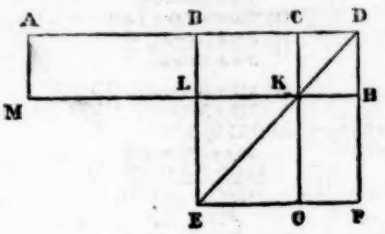
1. If a straight line be divided into two equal parts, and also into two unequal parts; the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

Euclid: Book II., Prop. 5.

2. To divide a given straight line into two parts, so that the rectangle contained by the whole and one of the parts, shall be equal to the square on the other part.

Euclid: Book II., Prop. 11.

3. Construct a rectangle equal to the difference between two given squares.



Let AB and BC be the sides of two given squares. It is required to construct a rectangle = their difference.

Produce ABC to D and make BD = AB. On BD construct sq. BEFD. Join DE. Through C draw CKG parallel to BE or DF. Through K draw HLM parallel to AD, and through A draw AM parallel to BE. Rectangle AK = difference between sqs. AB and BC.

BF = sq. on BD (const.) and BD = AB (const.)

∴ BF = sq. on AB. And LG = sq. on BC (II. 4.)

∴ Gnomon BHG = their difference.

∵ AB = BD, ∴ Rect. AL = rect. BH. And BK = KF (I. 43.) ∴ AK = BHG.

∴ AK = difference of sqs. AB and BC.

Q. E. F.

Algebra.

(*Answer two Questions, including No.* 3, *if you can.*)

1. Multiply together $\frac{a^2-x^2}{c^2-x^2}$, $\frac{bc+bx}{a^2+ax}$, $\frac{3ax}{4by}$, and $\frac{c-x}{a-x}$

$$\frac{a^2-x^2}{c^2-x^2}\times\frac{bc+bx}{a^2+ax}\times\frac{3ax}{4by}\times\frac{c-x}{a-x}$$

Cancel 1st and 4th terms

$$=\frac{a+x}{c+x}\times\frac{bc+bx}{a^2+ax}\times\frac{3ax}{4by}$$

Cancel 1st and 2nd terms

$$=\frac{b}{a}\times\frac{3ax}{4by}$$

$$=\frac{3x}{4y}. \quad \text{Ans.}$$

2. Find the square root of

$$25x^4-30ax^3+49a^2x^2-24a^3x+16a^4$$

$$\begin{array}{l|l} 25x^4-30ax^3+49a^2x^2-24a^3x+16a^4 & \text{Ans. } 5x^2-3ax+4a^2. \\ 25x^4 & \\ \hline 10x^2-3ax & -30ax^3+49a^2x^2 \\ & -30ax^3+9a^2x^2 \\ \hline & 40a^2x^2-24a^3x+16a^4 \\ & 40a^2x^2-24a^3x+16a^4 \\ \hline & \end{array}$$

$$10x^2-6ax+4a^2$$

3. Solve the equations :—

$$(1)\ 21y+20x=165.$$
$$77y-30x=295.$$
$$(2)\ 780x^2-73x+1=0.$$
$$(3)\ \frac{x+4}{x-4}+\frac{x-4}{x+4}=\frac{10}{3}.$$

(1) $21y+20x=165$. (I.)
$77y-30x=295$. (II.)

Mult. (I.) by 3, and (II.) by 2.

$$63y+60x=495$$
$$154y-60x=590$$
$$217y=1085$$
$$y=5.$$

Substitute value of y in (I.)

$$105+20x=165$$
$$20x=60$$
$$x=3$$

$x=3$, $y=5$. Ans.

(2) $780x^2-73x+1=0$.

$$x^2-\tfrac{73}{780}x=-\tfrac{1}{780}$$
$$x^2-\tfrac{73}{780}x+(\tfrac{73}{1560})^2=-\tfrac{1}{780}+(\tfrac{73}{1560})^2$$
$$x-\tfrac{73}{1560}=\pm\tfrac{47}{1560}$$
$$x=\tfrac{73}{1560}+\tfrac{47}{1560}=\tfrac{120}{1560}=\tfrac{1}{13}.\text{ Ans.}$$
$$x=-\tfrac{47}{1560}+\tfrac{73}{1560}=\tfrac{26}{1560}=\tfrac{1}{60}.\text{ Ans.}$$

$$(3)\ \frac{x+4}{x-4}+\frac{x-4}{x+4}=\frac{10}{3}.$$
$$3(x^2+8x+16)+3(x^2-8x+16)=10(x^2-16)$$
$$6x^2+96=10x^2-160$$
$$-4x^2=-256$$
$$x^2=64$$
$$x=8,\ -8.\text{ Ans.}$$

Mensuration.

The diameter of a circle is 12 ft. : find the area of a square inscribed in it.

Diameter of circle = diagonal of sq.

Area of sq. on diagonal = area of sqs. on two sides. (Euclid, I. 47.)

∴ Area of sq. on one side, that is, the sq. in circle = ½ sq. on diag.

∴ Area of sq. $=\frac{12\times12}{2}=72$ sq. ft. Ans.

Arithmetic.

FEMALES.

1. By selling a carriage for £73 3s. 0d. I should lose 5 per cent. At what price must I sell it to gain 15 per cent.?

£73 3s. = 100 − 5 = 95.

£	s.		£	s.
95		: 115 ::	73	3

∴ 88 11. Ans.

2. Two trains start at the same time from Sheffield and Leicester, and proceed towards each other at the rates of 30 and 50 miles per hour respectively. When they meet it is found that one train has run 14½ miles farther than the other. Find the distance between Sheffield and Leicester.

Faster train gains 20 miles in 1 hour.

∴ Time to gain 14½ miles =

mls.	mls.		mins.	mins.
20	: 14½ ::		60	: 43½.

The distance run by the trains in 1 hour = 50 + 30 = 80 miles.

∴ Distance run in 43½ mins. =

mins.	mins.		mls.	mls.
60	: 43½ ::		80	: 58. Ans.

3. A, B, and C rent a field jointly for £25 12s. 5d. ; A puts in 15 sheep for 6 months, B 45 sheep for 8 months, and C 81 sheep for 4 months ; what should each pay towards the rent?

A 15 × 6 = 90 shares.
B 45 × 8 = 360 ,,
C 81 × 4 = 324 ,,
774

			£	s.	d.	£	s.	d.	
∴ A's proportion = 774	: 90	::	26	12	5	:	2	19	7 Ans.
B's ,, = 774	: 360	::	26	12	5	:	11	18	4 Ans.
C's ,, = 774	: 324	::	26	12	5	:	10	14	6 Ans.

4. What principal must have been deposited in a bank paying 4 per cent. so that at the end of 8 years the principal and interest amounted to £4785?

£100 would become 100 + (8 × 4) = £132.

£	£	£	£
132	: 4785 ::	100	: 3625. Ans.

Grammar.

MALES AND FEMALES.

1. I would the great world grew like thee
Who grewest not alone in power
And knowledge ; but from hour to hour
In reverence and in charity.

—TENNYSON.

Analyse this stanza ; and explain, if you can, its metre.

ANALYSIS.

Sentence.	Kind of Sent.	Connective.	Subject.	Predicate.	Object.	Extension.
(*a*)						
I would	Prin. S.		I	would		
(*b*)						
the great world grew like thee	Noun. S. Obj. to (*a*)	*that* und.	the great world	grew		like thee
(*c*)						
who grewest not alone in power and knowledge	Adj. S. to *thee* in (*b*)	*In rel*	who	grewest	in power and knowledge (ind.)	not only
(*d*)						
but from hour to hour in reverence and in charity	Adj. S. to *thee* in (*b*)	but	[who]	[grewest]	in reverence and in charity (ind.)	from hour to hour

The stanza is a tetrameter of four lines, the measure of which is Iambic, that is, having an unaccented and accented syllable in each foot. The rhyming lines are the first and fourth, and the second and third.

2. Give the etymology and exact meaning of as many of the following words as you can :—

Fortress, Fortitude, Subscribe, Superior, Domination, Rectitude, Impossible, Construction, Export.

Fortress—derived from Latin *fortis*, strong, through the French *forteresse ;* a strong, fortified place.

Fortitude—from the Lat. *fortitudo*, strength ; originally it meant strength, now it refers to strength of mind to bear ills.

Subscribe—from Lat. *sub*, under, and *scribo*, I write ; to write underneath ; to sign one's name ; to promise to give money by writing underneath.

Superior—a Latin comparative from *super ;* higher in rank, position, or quality.

Domination—from Lat. *dominatus*, mastery ; lordship, mastery, government, sometimes tyranny.

Rectitude—from Lat. *rectitudo*, right ; correctness of conduct or principle ; uprightness.

Impossible—from Lat. *im*, not, and *possibilis*, possible (*possum*, to be able) ; not possible, that which cannot be accomplished.

Construction—from Lat. *con*, together, and *struo*, I build ; that which is constructed or built together.

Export—from Lat. *ex*, out, and *porto*, I carry ; that which is carried out, or sent from one country to another.

3. Give an example of an 'Infinitive of purpose ;' and also of an Infinitive used as equivalent to a noun.

Infinitive of purpose :—

I come to bury Cæsar.

Infinitive used as a noun:—

To err is human; to forgive, divine.

4. Say what you know about the life or writings of Milton, Pope, and Dr. Johnson.

Milton was a prominent supporter of the Parliament in the time of Charles the First. He wrote many political pamphlets in favour of that body, and became Latin Secretary to Cromwell. His greatest work was a descriptive poem on the Fall, entitled 'Paradise Lost.' It was written after the Restoration, when Milton was in poverty and afflicted with blindness. He wrote also 'Paradise Regained,' 'Comus,' a play, 'Samson Agonistes,' 'L'Allegro,' and 'Il Penseroso.'

Alexander Pope's chief works are, 'The Rape of the Lock,' a short poem in imitation of the actions of the Greek heroes; and a translation of the 'Iliad' of Homer, still extensively read and admired for the ease and elegance of its verse. He is considered one of the most finished of English poets.

Dr. Samuel Johnson was born at Lichfield. He died in 1784. He is chiefly known through the biography of Boswell. He compiled an 'English Dictionary,' wrote 'Rasselas,' an Eastern Tale; 'The Lives of the Poets,' a poem called 'London,' and conducted several magazines.

Geography.

1. State some of the chief physical differences between the New World, North and South America; and the Old World, Europe, Asia, and Africa.

The axis of greatest length in the New World is from north to south, in the Old World from east to west. The mountain ranges in the N.W. are near the coast, in the O.W. nearer the centre. The rivers in the N.W. nearly all flow in an easterly direction, and are of great length, those on the west slope of the great mountain chain being short and rapid. In the O.W. they flow from all slopes, and are more uniform in length. There is a much greater proportion of land in the Torrid Zone in the O.W. than in the N.W.

The coast of the Old World is generally much more indented than that of the N.W. Great fresh-water lakes are a marked feature of the N.W., while those of the O.W. are comparatively few, and of these many are salt. The general level of the O.W. is higher than that of the N.W., especially in Asia.

2. Explain as to a class the nature and causes of tides.

Bodies attract each other, according to their size and distance apart. The sun, moon, and earth thus have an influence over each other. The water of the earth being free to move, is most susceptible to this influence. The moon being much nearer to the earth than the sun, although a small body, attracts the waters of the earth more than the sun. The waters, therefore, accumulate on the side of the earth nearest the moon. The solid earth is also attracted, but the force exerted being felt at a greater distance, and the earth moving as one mass, the movement towards the moon is not so great as the water. The waters on the opposite side of the earth being most remote, are not so much acted on, and as the earth is drawn from them, there is an accumulation on that side also. As the moon travels daily round the earth, the heap of waters follows also, and there are thus two times of high water at every part of the coast every day. And as the waters are drawn away from that part of the coast which is at right angles to the moon's influence, there is low water at every place also twice a day.

The sun's influence is sometimes added to that of the moon. At other times it acts against it. (Show by diagrams.)

3. What four planets are nearest to the sun? Describe one of them.

The four primary planets nearest the sun are Mercury, Venus, Earth, and Mars, although Vulcan and Pluto are said to have orbits inside of Mercury.

Of these Venus presents a much more brilliant appearance than any other, and is known to us as the morning and evening star. As its orbit is within that of the earth, it can never appear at a greater angular distance from the sun than about 45°; it will also be seen in various phases, and will sometimes make a transit across the sun's disc. Its diameter is about 7500 miles, and its yearly revolution takes place in 235 days. It rotates on its axis in 23½ hours. It is sometimes so brilliant that it can be seen even during daylight.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

The needlework specimens will be collected by the Inspector at the expiration of one hour after the distribution of the examination paper.

Arithmetic.

MALES.

1. If a grocer buys sugar at 30s. per cwt., and sells it at 3½d. per lb., what per cent. does he gain?

	s.	d.
Selling price = $3\frac{1}{2} \times 112$ =	32	8
Cost price =	30	0
Gain =	2	8

30 : 100 :: 2⅔ : 8⅔. Ans.

2. What sum of money, lent at 5 per cent. per annum compound interest, will amount in 2½ years to £904 1s.?

Compound interest on £100.

	£	s.	d.	
$5 = \frac{1}{20}$	100	0	0	
	5	0	0	
$5 = \frac{1}{20}$	105	0	0	End of 1st yr.
	5	5	0	
For ½ yr. $5 = \frac{1}{40}$	110	5	0	End of 2nd yr.
	2	15	1¼	
	£113	0	1¼	End of 2 yrs. and 6 mos.

£ s. d. £ s. £ £
113 0 1¼ : 904 1 :: 100 : 800. Ans.

3. A lends £1815 at 4 per cent. interest, and B invests the same amount in 4½ per cent. debentures at 110; after a year B sells out at 111½. How much has B made more than A? (Omit brokerage.)

A receives as interest $\frac{1815 \times 4}{100} = £72\ 12s.$

∴ At the end of the year he has £1815 + £72 12s. = £1887 12s.

B receives as interest $\frac{1815 \times 4\frac{1}{2}}{110} = £74\ 5s.$

He sells out for $\frac{1815 \times 111\frac{1}{2}}{110} = £1839\ 15s.$

∴ He has at the end of the year £1839 15s. + £74 5s. = £1914.

B has more than *A*, £1914 − £1887 12s.
= £26 8s. Ans.

4. A owes B £2926, payable 12 months hence. If A pays B 4 months hence, how much ought he to pay in exact discharge of the bill, interest being reckoned at 4 per cent. per annum?

A pays *B* eight months before bill is due.

£100 in 8 months at 4 per cent becomes $(100 + \frac{8}{12}$ of $4)$
$= 102\frac{2}{3}$

∴ Present worth of £2926 for 8 mos. =

£ £ £ £
102⅔ : 100 :: 2926 : 2850. Ans.

History.

MALES AND FEMALES.

1. When and how did the Colonial Empire of England begin? Give some general description of its extent at the present time.

After the discovery of America by Columbus, permission was given to John Cabot and his son to search for islands, countries, and regions before unseen, and take possession of them as vassals of the English Crown. They discovered Newfoundland and Labrador, reaching the country before Columbus. In Elizabeth's reign, however, the actual colonization began. Virginia was the first settlement made (1584). Other colonies were afterwards founded by those who left the country, either from persecution or war. The growth of the number and extent of the colonies has been greatest in modern times.

England now possesses nearly the whole of India, all Ceylon, Australia, New Zealand, 3½ million square miles in North America, half a million square miles in South Africa, besides

islands in the West Indies and the Pacific, settlements on the West Coast of Africa, on the east side of the Bay of Bengal, and in other places.

The British Empire is the largest in the world, except Russia, and the most populous, except China.

2. How did our forefathers look upon barracks and a standing army? How do you explain the change in popular feeling on this subject?

The foundation of a standing army and barracks was looked upon by the people of this country with a feeling of distrust, and met with considerable opposition. They saw in the one only a means of interference and meddling abroad and an increase of the power of the king, and in the other a means of oppression and taxation at home.

The change has come about since the growth of the power of Parliament, the limitation of the power of the king, the extension of our colonial empire, the increase of population and manufactures, and the spread of education and popular power by the extension of the franchise to almost all classes of people.

3. When did the House of Hanover come to the throne? Show the names and relationship of all our sovereigns of that House, with their dates.

The Act of Settlement passed after the accession of William III. provided that the crown should pass to his children if he left any, then to Anne or her heirs, and in default of either to the descendants of Elizabeth, daughter of James I. Elizabeth married the Elector Palatine, and had issue Sophia, who married Ernest Augustus, the Elector of Hanover. On the death of Queen Anne, George, the son of the Electress Sophia, became King of England.

The sovereigns of the House of Hanover are:—

	A.D.	A.D.
George I., great grandson of James I. ...		1714—1727
George II., son of George I.		1727—1760
George III., son of Frederick, Prince of Wales, and grandson of George II.	}	1760—1820
George IV., son of George III.		1820—1830
William IV., brother of George IV. ...		1830—1837
Victoria, daughter of the Duke of Kent, and niece of William IV.	}	1837

4. Who sit in the House of Peers? Explain the name, and discuss the constitutional advantages of a Second Chamber.

The House of Peers consists of the Lords Spiritual and Temporal of England, and the Representative Peers of Ireland and Scotland. Twenty-six Bishops of the Church of England occupy their seats for life, or till the resignation of their bishopric. The Lords Temporal are of five orders, Dukes, Marquises, Earls, Viscounts, and Barons. Their title is hereditary. The representative peers of Ireland are elected for life, the Scottish peers for a single Parliament only.

The word means *an equal*, and is derived from the Latin *par*, equal, and the persons sitting in the House of Lords sit there as equals.

Perhaps the chief advantages of a Second Chamber are, that it provides for the reconsideration of measures which may have been hurriedly passed, or only imperfectly and partially considered by a body of men who are not subject to the capricious changes of opinion which often occur among a numerous and partially-educated population.

Teaching.

Write notes of a lesson on one of these subjects:—

The four seasons.
Gold.

Cause of Seasons.—The inclination of the earth's axis to the plane of its orbit. *Illustration.* Place lamp on table, and move globe round it with axis perpendicular. From this derive, that half of the earth receives light and heat at once; that if the earth's axis were perpendicular there would never be any change of season, each place on the earth would have always 12 hours day and 12 hours night.

Inclination of Axis, and its Effects.—23½ degrees. Now show the effects of inclining the axis, and keeping the inclination always parallel to itself. Place the globe with north pole turned towards lamp. Make it revolve, and show that parts round about the North Pole never lose sight of the sun during the revolution; then draw attention to the South Pole, and elicit that the people there never see the sun during that revolution.

Changes places, and observe change of season. These give winter and summer clearly.

Next move globe slowly, till it occupies place midway between former positions. Show that North Pole and South Pole are then equally distant from sun, and that each place will have twelve hours day and night in the revolution.

From this derive, that the North Pole and the district 23½ degrees around it passes from all day gradually to all night during the revolution, that the amount of heat received varies according to length of day; that this variation we name the seasons.

The Seasons.—Spring, Summer, Autumn, Winter. Name the months for each in this country, and show that the further a place is from the North or South Pole the less difference there is in the seasons.

Benefits of the Seasons.—Nearly all parts of the earth are rendered habitable; greater variety of climate; greater diversity of products; temperate zones produce fruits which would never ripen but for this change.

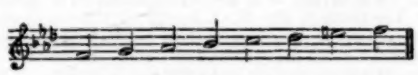
Music.

A quarter of an hour allowed for this paper.

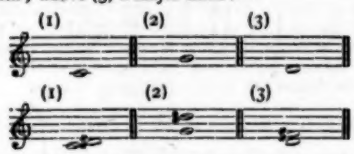
(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*. The questions in the Tonic Sol-fa Notation will be found at the end.)

1. Write in the Treble clef the signature and the ascending scale of F minor, using the minor or flat sixth and the major or sharp seventh.

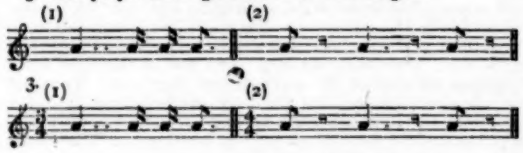
1.



2. Write above (1) an augmented second; above (2) an augmented fifth; above (3) a major third:—



3. Add proper time-signatures to the following:—



TONIC SOL-FA NOTATION.

1. Write (1) above *doh* an augmented second; (2) above *soh* an augmented fifth; (3) above *ray* a major third.

1. (1) *Re*; (2) *re*^{1}; (3) *fe*.

2. In the minor or *lah* mode (1) which is the essential or minor sixth and (2) which is the essential or major seventh?

2. (1) *Fah*; (2) *se*.

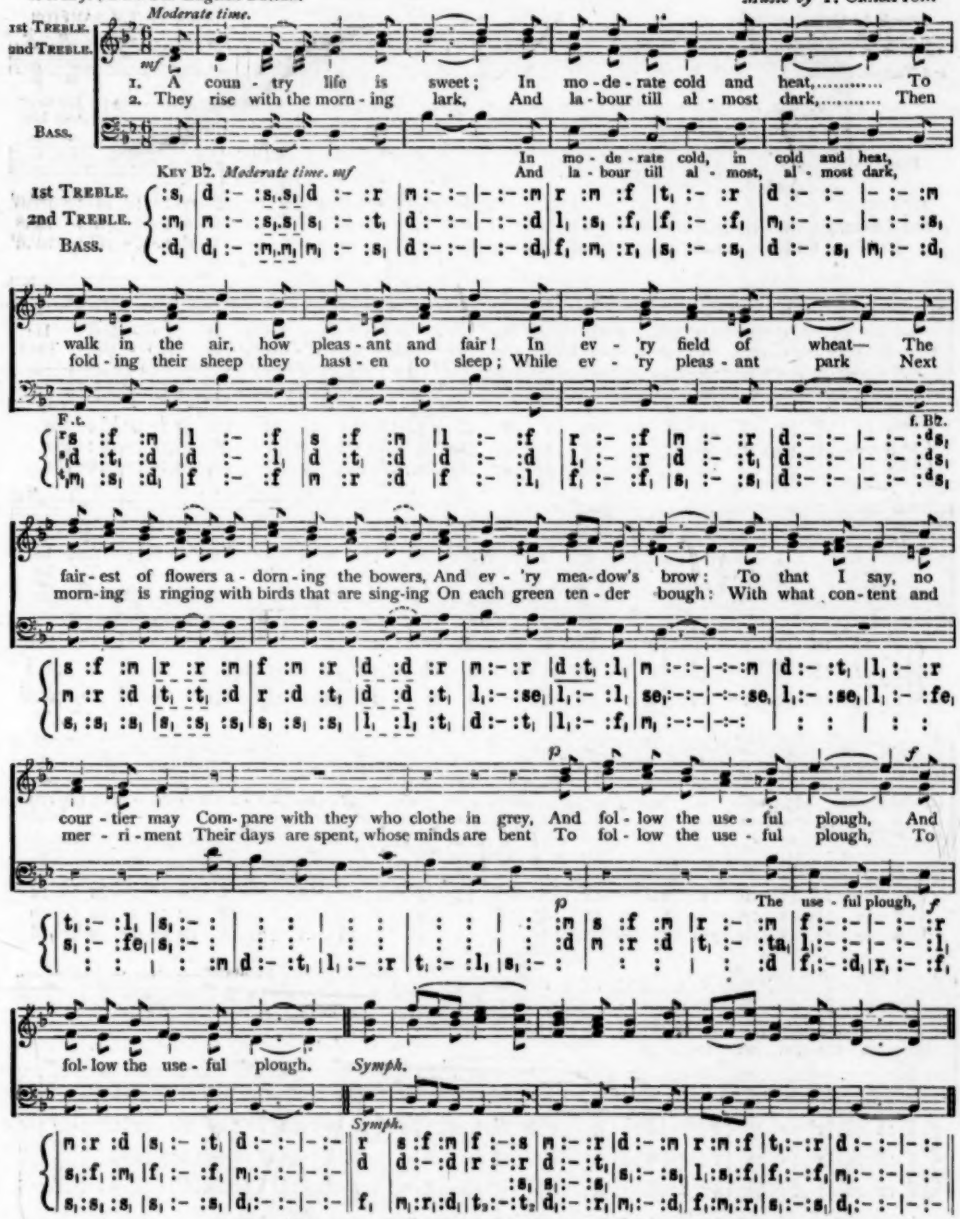
3. Write the following in six-pulse measure by trebling the value of every note:—

| s ,n ,l : s ,d ,- | n ,- ,r : d ‖

3.

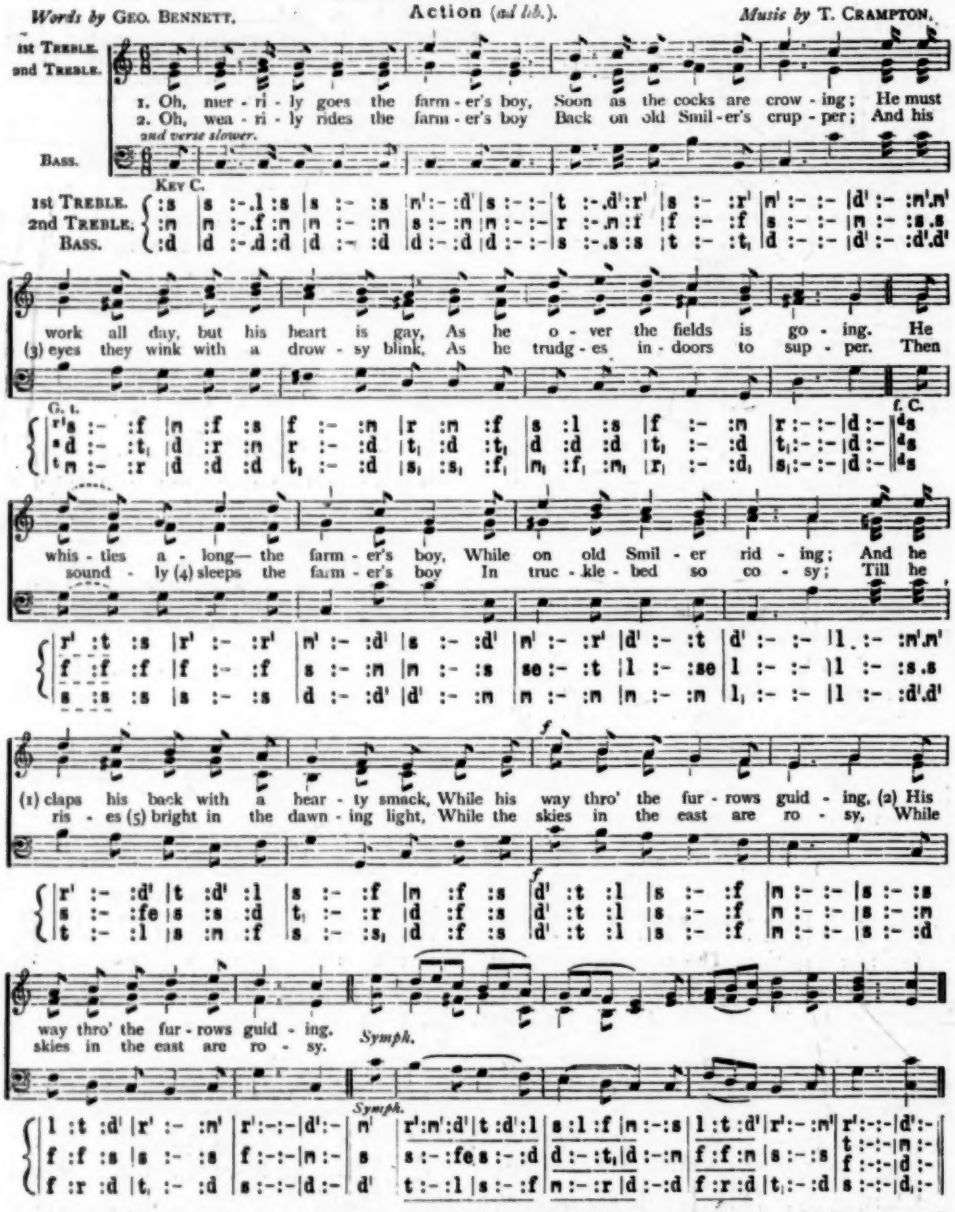
| s : n : l | s : d : - | n : - : r | d : - : - ‖

THE USEFUL PLOUGH.

*Words from an Old English Ballad.** *Music by* T. CRAMPTON.

Moderate time.
1st Treble.
2nd Treble.
Bass.
mf
1. A coun - try life is sweet; In mo - de - rate cold and heat,..... To
2. They rise with the morn - ing lark, And la - bour till al - most dark,..... Then
In mo - de - rate cold, in cold and heat,
And la - bour till al - most, al - most dark,
Key B♭. Moderate time. mf
walk in the air, how pleas - ant and fair! In ev - 'ry field of wheat— The
fold - ing their sheep they hast - en to sleep; While ev - 'ry pleas - ant park Next
F.t.
f. B♭.
fair - est of flowers a - dorn - ing the bowers, And ev - 'ry mea - dow's brow: To that I say, no
morn - ing is ringing with birds that are sing - ing On each green ten - der bough: With what con - tent and
p
f
cour - tier may Com - pare with they who clothe in grey, And fol - low the use - ful plough, And
mer - ri - ment Their days are spent, whose minds are bent To fol - low the use - ful plough, To
p
The use - ful plough, f
fol - low the use - ful plough.
Symph.
Symph.

* The older copies of this Ballad have the words "Painful Plow."

THE FARMER'S BOY.

Words by GEO. BENNETT. Action (*ad lib.*). *Music by* T. CRAMPTON.

1st Treble.
2nd Treble.
Bass.
1. Oh, mer - ri - ly goes the farm - er's boy, Soon as the cocks are crow - ing; He must
2. Oh, wea - ri - ly rides the farm - er's boy Back on old Smil - er's crup - per; And his
2nd verse slower.
Key C.
work all day, but his heart is gay, As he o - ver the fields is go - ing. He
(3) eyes they wink with a drow - sy blink, As he trudg - es in - doors to sup - per. Then
G. t.
f. C.
whis - tles a - long— the farm - er's boy, While on old Smil - er rid - ing; And he
sound - ly (4) sleeps the farm - er's boy In truc - kle - bed so co - sy; Till he
(1) claps his back with a hear - ty smack, While his way thro' the fur - rows guid - ing, (2) His
ris - es (5) bright in the dawn - ing light, While the skies in the east are ro - sy, While
way thro' the fur - rows guid - ing.
skies in the east are ro - sy.
Symph.
Symph.

(1) Slap right hand on the leg. (2) Point straight ahead. (3) Blink the eyes, as if sleepy. (4) Close eyes, and imitate being asleep. (5) All suddenly jump up, and finish the song standing.

Chemistry of the Non-Metallics.

BY EDWARD AVELING, D.SC. LONDON.

[This series of articles, whilst dealing with the subjects required by the University of London for the Matriculation Examination and with those required at the Elementary Stage of the Inorganic Chemistry (Branch X.) Science and Art Department, is intended as a practical guide to the philosophical and systematic study of the non-metallics.]

CHAPTER IV.—HYDROGEN—(*continued*).

PROPERTIES. DIFFUSION OF GASES.

D. *The Properties of Hydrogen.*—If the student has carefully observed the behaviour of the gas prepared in any one of the four experiments given above he will be able to make out its properties.

(1) *Condition.*—A gas at ordinary temperatures. Until recently all efforts to liquefy hydrogen had failed. The two chief agents in liquefying gases are reduction of temperature and increase of pressure. Each of these helps to bring the particles of the gas closer to each other. Cohesion between these particles triumphs over the repulsion of them one by the other, and a liquid results. A pressure of 3,000 atmospheres, *i.e.*, 3,000 times as great as the pressure of the air at the earth's surface, or 3,000 times 1,033 grams on the square centimetre has been applied to hydrogen without liquefying it. Hence hydrogen was for a long time spoken of as a permanent gas, *i.e.*, one that could not be reduced to the liquid state. In 1878-9, however, two Frenchmen, MM. Cailletet and Pictet, working quite independently one of the other, succeeded by the use of very ingenious methods in liquefying hydrogen and all the other gases said to be permanent.

The method employed by M. Pictet is as follows. The tube of glass containing the gas to be liquefied (5 metres long, 14 mm. in external diameter, 4 in internal, and therefore 5 mm. in thickness) is placed in a tube containing solid carbon dioxide. The latter is frozen by being placed in a tube containing liquid sulphur dioxide. The vapour of this last is constantly drawn off from the surface of the liquid by means of a vacuum-pump. The evaporating sulphur dioxide, producing a temperature of $-65°$ to $-70°$, cools the carbon dioxide. The solid carbon dioxide has a temperature of $-140°$. The gas within the innermost tube is, at the same time as it is cooled by the frozen carbon dioxide, subjected to great pressure (500 atmospheres, *e.g.*). On turning a stop-cock at the free projecting end of the tube containing the gas to be liquefied, the latter escapes as a liquid.

The method employed by M. Cailletet is as follows. The gas to be liquefied is placed in a small tube of glass, surrounded by a freezing mixture, and so arranged that the gas may at a certain moment be put into connection with the air. This glass tube opens below into a cylinder of steel, containing mercury. This mercury, pressed on by water that is forced into the cylinder from a massive steel cylinder, presses on the gas. When the latter, lowered in temperature by the freezing mixture and compressed by the mercury that is under pressure from the forced-in water, is suddenly allowed to escape into the air its expansion causes a very great reduction of temperature and the gas is liquefied.

(2) *Effect on the Senses.*—Without taste or odour; invisible and colourless.

(3) *Specific Gravity.*—The lightest terrestrial body known. It is indeed the standard of comparison for all gases as to weight. The specific gravity of a body is its weight in reference to the weight of an equal volume of some standard body. Its density is the amount of matter, or the mass, of a certain volume of any substance, as compared with the mass of an equal volume of the standard. The student is warned not to confuse specific gravity with density, or weight with mass. A body may have no weight. It must have mass. As hydrogen is the lightest substance known, it is taken as the standard for gases. Its specific gravity and its density alike are represented by the number 1. The air is sometimes taken as the standard for gases. There are two reasons why it is not a good standard. It is a mixture, not an element, and it is, compared with hydrogen, a heavy gas. Air is 14·47 times as heavy as hydrogen. Hence the specific gravity of any gas can be expressed upon the air-scale by dividing its specific gravity upon the hydrogen scale by 14·47. The specific gravity of hydrogen on the air-scale is $1 \div 14{\cdot}47 = {\cdot}069$.

By the law explained on page 259, 11·2 litres of hydrogen at 0° and 760 mm. weigh 1 gram, therefore 1 litre weighs $\frac{1}{11{\cdot}2}$ grams = ·0896 grams. This number ·0896, much used in chemical arithmetic, is called the crith, κριθή (crithē) = a barleycorn. The weight of a litre of any other gas may be calculated by multiplying the crith by the number representing specific gravity of the gas.

(4) *Solubility.*—Very little soluble in water. 100 cc. of water at normal temperature and pressure dissolve 1·93 cc. of hydrogen.

(5) *Relation to Combustion.*—Inflammable, but not a supporter of combustion. If a lighted taper is plunged into the gas, the taper goes out, and the hydrogen burns, uniting with the oxygen of the air to form hydrogen oxide, or steam. Hydrogen and oxygen mixed together burn on application of a light with explosive violence. If mixed in the proportion of 2 and 1, their combining proportions by volume, the explosion is dangerously violent.

Symbols of the combustion of hydrogen:

$$\begin{array}{ccccc} 2H^2 & + & O^2 & = & 2H^2O \\ 4 & + & 32 & = & 36 \\ 4 \text{ vols.} & & 2 \text{ vols.} & & 4 \text{ vols.} \end{array}$$

It will be seen that the two gases unite in the proportion of 4 and 32 by weight to form 36 by weight of water, or (dividing by 4) in the proportion of 1 to 8 to form 9 by weight of water.

The volume-relationship demands close attention. 4 vols. of hydrogen with 2 of oxygen only form 4 vols. of steam. To understand this we must turn to the law explained on page 259, and see how the weights and volumes of compound gases are related.

1 gram hydrogen at 0°C. and under 760 mm.
16 grams oxygen " " " "
14 " nitrogen " " " "
} occupy each 11·2 litres.

And, generally, the number of grams of any *element* gas represented by the weight-number of the element occupy at normal temperature and under normal pressure 11·2 litres.

The weight-number of the compound gas, steam (H^2O) = 18.

18 grams steam (H^2O) at normal temperature and pressure occupy 22·4 litres, and generally the number of grams of any *compound* gas represented by the weight-number of the compound, occupy at normal temperature and under normal pressure 22·4 litres or 2 volumes.

In the special case under consideration, therefore, the 4 vols. of hydrogen and the 2 vols. of oxygen are condensed into 4 vols. of steam.

EXERCISES ON THE BURNING OF HYDROGEN (*solved*).

39. 20 grams hydrogen are burnt. What weight of oxygen is required and what weight of steam is formed?

4 grams H require 32 O and form with them 36 H^2O
1 gram " requires $\frac{32}{4}$ O and forms " $\frac{36}{4}$ "
20 grams " require $\frac{32 \times 20}{4}$ O and form " $\frac{36 \times 20}{4}$ "
= 160 grams O, 180 grams H^2O.

40. 22·4 litres steam are required. What weight of hydrogen, and what volume of oxygen are needed?

4 vols. = 44·8 litres H^2O need 4 grams H and 22·4 litres O
1 litre " needs $\frac{4}{44{\cdot}8}$ " " $\frac{22{\cdot}4}{44{\cdot}8}$ "
22·4 " " need $\frac{4 \times 22{\cdot}4}{44{\cdot}8}$ " $\frac{22{\cdot}4 \times 22{\cdot}4}{44{\cdot}8}$ "
= 2 grams H, 11·2 litres O.

41. How many cc. of oxygen must be mixed with 1 gram of hydrogen that upon explosion nothing but steam may be left?
4 grams H require 2 vols. = 22·4 litres = 22400cc. O
1 gram ,, requires $\frac{22400}{4} = 5600$ cc. O.

42. A mixture of equal volumes of oxygen and hydrogen is exploded. What gas will be left after the explosion, and what proportion of the original mixture will it equal?
4 vols. H need 2 vols. O
1 vol. ,, needs $\frac{1}{2}$ vol. ,, $= \frac{1}{4}$
Hence all the H will be used and $\frac{1}{4}$ the O,
$\therefore \frac{1}{4}$ of $\frac{1}{4}$, or $\frac{1}{8}$ of the original mixture will be left.

43. 75cc. oxygen and 25cc. hydrogen are exploded. Supposing that no condensation takes place, what vol. of steam is formed, and what volume of which of the two gases is left?
4 vols. H with 2 vols. O = 4 vols. H^2O
1 vol. ,, ,, $\frac{1}{2}$ vol. ,, = 1 vol. ,,
25 vols. ,, ,, $\frac{25}{4}$ vols. ,, = 25 vols. ,,
$\therefore 75 - 12\frac{1}{2} = 62\frac{1}{2}$cc. O and 25cc. H^2O are left.

EXAMPLES ON THE BURNING OF HYDROGEN (*for solution*).

33. How much oxygen by weight and by volume is necessary for the combustion of $\frac{1}{2}$ gram of hydrogen?...4 grams, 2·8 litres.

34. 22·4 grams water are required. What weight hydrogen and oxygen must be taken?.....$24\frac{8}{9}$ and $199\frac{1}{9}$.

35. What weight of hydrogen must be mixed with 1 gram of oxygen, that upon explosion nothing but steam may be left? ... $\frac{1}{8}$ gram.

36. A mixture of equal weights of oxygen and hydrogen is exploded. What gas will be left after the explosion, and what proportion by weight of the original mixture will it equal?.. ... Oxygen; $\frac{7}{8}$.

37. 12cc. of hydrogen and 15cc. of oxygen are exploded. What gases are left after the explosion, supposing that no condensation takes place?.....12cc. steam, 9cc. oxygen.

38. What volume of hydrogen must be mixed with 8 grams oxygen that after the explosion 500cc. of hydrogen may be left? 11700cc.

(6) *Specialties.*—Hydrogen by its extreme tenuity renders sounds very weak. A bell rung in a jar of hydrogen can scarcely be heard. Hydrogen is a great reducing agent, *i.e.*, it readily takes away oxygen from compounds containing that element, and uniting with it forms water. If the gas is driven over the magnetic iron oxide formed in the experiment described on page 378, water is formed and iron is left.

Symbols ..... $Fe_3O_4 + 4H^2 = 4H^2O + 3Fe.$
Weight numbers and volumes $56\times3+16\times4+8 = 4(2+16) + 3\times56$
232 72 168
8 vols.

QUESTION ON THE REDUCING ACTION OF HYDROGEN (*solved*).

43*a*. How much iron will remain as a free metal after 11·2 litres hydrogen have been passed over heated iron rust?
If $8\times11\cdot2$ litres H. are used, 168 grams Fe remain.
$1\times11\cdot2$,, ,, ,, $\frac{168}{8}$,, ,, = 21 grams.

QUESTION ON THE REDUCING ACTION OF HYDROGEN (*for solution*).

(38*a*.) Find weight of water that may be formed by the reducing action of 7 grams hydrogen .....63 grams.

One other specialty of hydrogen is its power of decomposing certain salts when it is just liberated from a compound that contains it, *i.e.*, when it is in a *nascent* condition (nascor = I am born). Pass hydrogen gas into a solution of ferric chloride (Fe_2Cl_6), and no change occurs. But place in a solution of ferric chloride (which is of a yellowish colour) some zinc and sulphuric acid, and the nascent hydrogen decomposes the salt and discharges the colour.

The rapidity of its diffusion is another special point. Diffusion is the passage of one gas into the space occupied by another. Take some plaster of Paris, mix it with water, spread the mixture on filter paper. Take a glass tube $\frac{1}{4}$ of an inch in diameter, and some two or three feet long. Press one end of the tube into the moistened plaster of Paris, and let the plaster set. The tube will be closed at one end by a porous plug of plaster of Paris. Fill the tube with hydrogen, and place its open end in a vessel

Fig. 14.

containing any coloured liquid. (Fig. 14.) The liquid is seen to rise within the tube. The hydrogen is diffusing out through the plug more rapidly than air is passing in through the plug.

Another method of showing the diffusion of hydrogen is to join the tube with its porous plug to a U-shaped tube containing water, and to place over the plug-end a beaker (B, Fig. 15.) Pass hydrogen into this beaker, and

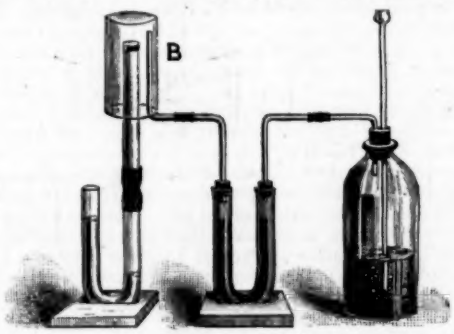


Fig. 15.

the hydrogen in the beaker B will pass through the porous plaster more quickly than the air passes out, and will force the water below up and out of the free limb of the bent tube.

It is found that the lighter a gas is, the more rapidly it diffuses. Experiments with various gases show that the power of diffusion of gases varies inversely as the square roots of their densities. Oxygen is 16 times as heavy as hydrogen. The square root of 16 is 4, of 1 is 1. Hydrogen diffuses 4 times as rapidly as oxygen.

EXERCISES ON THE DIFFUSION OF GASES (*solved*).

(44.) If in a certain time 200 cc. oxygen pass through a porous plug, what volume of hydrogen, and what volume of nitrogen will pass through in the same time under similar conditions?

Densities of oxygen, hydrogen, and nitrogen are 16, 1, 14.
Square roots of densities ,, ,, ,, 4, 1, $\sqrt{14}$.
Of gas with density whose sq. root is 4, 200 cc. diffuse.
,, ,, ,, 1, $200\times4 = 800$ cc. ,,
,, $\sqrt{14}$ $\frac{200\times4}{\sqrt{14}} = \frac{800}{3\cdot74}$,, ,,
$= 213\cdot9$ cc.

(45.) Compare the densities of two gases when one litre of the one and 6,400 cc. of the other diffuse out of the same tube under the same circumstances.

Vols. diffused = 1,000 cc. and 6,400.

$$\frac{\sqrt{(\text{density of the first})}}{\sqrt{(\text{density of the second})}} = \frac{64}{10} = \frac{32}{5}$$

$$\therefore \frac{\text{density of the first}}{\text{,, ,, second}} = \frac{32^2}{5^2} = \frac{1024}{25}.$$

EXAMPLES ON THE DIFFUSION OF GASES (*for solution*).

(39.) Compare the diffusion volumes of air and hydrogen. 3·803 : 1.

(40.) How much chlorine gas will diffuse while a litre of oxygen diffuses? ..... 671·1 cc.

(41.) What is the density of a gas 300 cc. of which diffuse in the same time as 1800 cc. of hydrogen? ..... 36.

(*To be continued.*)

Physiology.

BY ARTHUR NEWSHOLME, M.D. LOND.,

Gold Medallist and University Scholar, Physician to the City Dispensary.

CHAPTER XI.—THE CIRCULATION OF THE BLOOD—(*continued*).

The Mechanism of the Circulation.—The chief agents concerned in it are the following:—

1. The rhythmical action of the heart.
2. The elasticity and muscular contractility of the arteries.
3. The elasticity of the capillaries, and the relation between them and their surrounding tissues.
4. The valves of the veins, preventing reflux.
5. The effect of the contraction of voluntary muscles on the veins.
6. Inspiration favours the venous circulation, and expiration the arterial.

The Heart is the central organ of circulation. The course of the circulation through it has been already described. It must be distinctly remembered that the two sides are contracting synchronously, the heart being really a double organ, by which the blood is propelled in two different directions. The contraction of the auricles of the heart sends the blood into the corresponding ventricles, which were previously empty. This contraction might possibly drive the blood back into the large veins near the heart, as they are destitute of valves; but this is prevented by the fact that the veins are already full of blood flowing towards the heart, while the ventricles are empty, and consequently the blood flows in the direction of least pressure.

As soon as the blood comes in contact with the interior of the ventricular walls, it excites their contraction. This contraction completely empties them, forcing the blood into the aorta and pulmonary artery, which arise from the left and right ventricle respectively. But as these arteries are already full of blood, the ventricular contraction requires a longer time and greater force than the auricular. Why does no blood flow back into the auricular cavities? This is owing to the perfect adaptation of the mitral and tricuspid valves at the moment of ventricular contraction. The return of blood from the aorta and pulmonary artery is prevented by the closure of the semilunar valves, and the blood is consequently forced onwards by the elastic recoil of the arteries to the peripheral parts of the body.

The time during which an auricle or ventricle is contracting is called its *systole*; the *diastole* being the passive period of refilling. Thus there are four periods in the cycle of events: auricular diastole, auricular systole, ventricular diastole, and ventricular systole. Inasmuch, however, as the ventricular systole occurs at the same time as the auricle is being refilled, and the ventricular diastole at the same time as the auricular contraction, these periods may be reduced to two.

If we suppose a cardiac revolution, including these four events, to occupy $1\frac{1}{10} = \frac{11}{10}$ sec., the following will be the relative duration of each event:—Contraction of auricles, $\frac{1}{10}$ sec.; of ventricles, $\frac{4}{10}$ sec.; period of repose (no contraction of either auricle or ventricle), $\frac{6}{10}$ sec.

Sounds of the Heart.—When the ear is placed over the region of the heart, two sounds are heard, following each other in close succession, and succeeded by a short pause, and then a repetition of the same sounds.

The first sound is dull and booming. It corresponds in time to the visible impulse of the heart, which can be seen between the fourth and fifth left ribs, a little lower than the left nipple, and between it and the sternum. This impulse is owing to the tilting up of the heart at the moment of ventricular contraction. If one finger be placed on the chest at the point of cardiac impulse, and another on the radial pulse (at the wrist) of any individual, the impulse (as well as the first sound) will be found to momentarily precede the radial pulse.

The second sound is shorter and sharper than the first, and follows close after the radial pulse. The difference between the two sounds may be expressed by saying the words *lubb-dup*.

During 1st sound.	*During 2nd sound.*
Contraction of ventricles.	Commencement of dilatation of ventricles.
Commencement of dilatation of auricles.	Dilatation of auricles.
Closure of auriculo-ventricular valves.	Opening of auriculo-ventricular valves.
Opening of aortic and pulmonary valves.	Closure of aortic and pulmonary valves.
Impulse occurs.	

The cause of the second sound is the sudden closure and vibration of the semilunar valves on the two sides of the heart. Usually, the two sides produce one sound, but occasionally there is a lack of synchronism, and then a reduplication of the second sound occurs.

That this is the true explanation is abundantly proved by disease. When, owing to thickening or puckering of the valves, they do not properly approximate, the sound is replaced by a *bruit* or murmur.

The cause of the first sound is less certain. It is not due to the impulse of the heart's apex against the chest wall, as it occurs when the latter is removed. The two other explanations given are that it is due (1) to vibration of the auriculo-ventricular valves, or (2) that it is a muscular sound. The muscular view of its origin seems to be negatived by the fact that muscular sounds are only produced by tetanic contractions, while the cardiac contraction is a single spasm; and the valvular origin of it is strongly confirmed by the fact that it becomes much obscured

when the valves are diseased. Both views, however, present difficulties, and these are not removed by supposing that it is both a muscular and valvular sound.

The *work done by the heart* at each contraction is very considerable. Calculations are not altogether reliable; but the mean of various results, is that about six fluid ounces of blood are ejected by each ventricle during its systole by an average adult. It is evident that each ventricle must eject exactly the same amount, as, otherwise, the whole of the blood would eventually accumulate either in the systemic or pulmonary circulation. The pressure of the blood in the right ventricle is much less than that in the left (30 to 40 millimètres of mercury as compared with 200 mm.), but, owing to the smaller amount of peripheral resistance in the lungs, this is quite sufficient to drive out an equal quantity of blood.

It is probable that the amount of blood leaving the ventricles varies considerably at different times. Supposing six ounces leave the ventricles with each stroke, and that the weight of the blood is one-thirteenth part of the weight of the body, the whole of the blood will pass through the heart in thirty-two beats—*i.e.*, in about half a minute.

The *frequency of the heart's beat* varies greatly. In the adult its frequency averages seventy beats per minute. It is quicker in children than adults; in females than males, and in short persons than in tall. It is increased by exertion, and is quicker standing than sitting, and sitting than lying. It is quickened by increased rarity of the atmosphere, and most markedly affected by mental conditions.

Nervous Relations of the Heart.—All the phenomena hitherto considered are purely physical, and can be imitated by mechanical contrivances outside the body. An apparatus can be invented, driving a given amount of fluid from a central source into a complicated system of tubes. But such a system would lead, in the animal economy, not to nutrition but destruction. The brain and stomach, for instance, would receive their dole of blood with a fatal regularity whether they were working or resting. We must now turn our attention to the vital mechanisms which enable the supply of blood to be exactly adapted to circumstances.

The contraction of the heart is not under the control of the will; it is automatic, and the impulses causing it arise in the heart itself. This can be proved in the case of cold-blooded animals, like the frog or turtle, in which the heart continues to beat for considerable periods after its removal from the body, even after the cavities have been cleared of blood. If the ventricle of a frog's heart be divided from the auricle, both continue to beat. If the auricle be divided longitudinally, each half will go on beating spontaneously; and the division may even be carried further, with similar results. If the ventricle be divided longitudinally, each portion continues to pulsate; but if divided transversely, the lower half remains motionless, while the upper half pulsates. It is found that the parts possessing the power of spontaneous pulsation possess ganglia (composed of nerve cells, and fibres), while these are absent from the ventricles, except at the extreme base. It would appear, therefore, that the pulsations of the heart are associated with, and probably due to, the presence of these nerve ganglia in its substance.

The beat of the heart may be stopped, or, in other words, *inhibited*, by impulses sent along the vagus, or pneumogastric nerve. The effect varies with the amount of stimulus. If a weak electric current is sent along the vagus nerve of a rabbit no actual stoppage occurs, but only a lengthening of the pause between the beats. With a stronger current the heart stops in diastole for a varying period. The inhibitory effect of the vagus overcomes the rhythmical action of the cardiac ganglia. Atropin (the active principle of belladonna) overcomes the inhibitory power of the vagus by paralysing its peripheral terminations in the heart.

The inhibitory action of the vagus nerve may also be brought about by reflex action. A blow in the abdomen, for instance, may cause a nervous shock which, by transmission down the vagus, stops the heart. Sudden emotional influences, as in fainting, may stop the heart, the stimulus being carried along the vagus nerve; while other emotional influences may paralyse the inhibitory apparatus and cause violent palpitation.

The vagus nerves arise from a particular part of the medulla, known as the *cardio-inhibitory centre*, through which they are brought in relationship with other parts of the nervous system.

An increase of the arterial blood pressure is followed by a slowing of the pulse. This slowing of the pulse only occurs when the vagus nerves are intact. We may, therefore, infer that the result is due to the high blood pressure stimulating the cardio-inhibitory centre, and thus partially inhibiting the heart. A low blood pressure, on the other hand, leads to a quickening of the pulse, by a reversed mechanism.

(*To be continued.*)

—o—

The Discipline of the Mind.

BY W. C. COUPLAND, M.A., B.SC.,

Lecturer on Mental and Moral Science at Bedford College, London.

VII.—THE FORMATION OF HABITS AND CHARACTER.

THE whole process of Education may be described as a formation of habits, for the ideal of the Educator is a spiritual organism, whose operations are spontaneous without being irregular, free from hesitation and doubt, but correctly responsive to every call. The scene of conscious effort is for ever shifting, and we pass on to fresh conquests, trusting to the self-sustaining power of the system to keep our action true, even when in strictest parlance we know not what we do. The supreme office of volition, indeed, is to bring about its own effacement; for nothing is really well done, no virtue is ever really such, until the act has become automatic, the excellence second nature. We take infinite pains at first to bring all our energies to bear upon some special task, and, as the effort is prolonged and renewed, gradually experience a sense of diminished strain, until at last we find ourselves in the possession of powers which once seemed utterly beyond our wildest hopes. These remarks apply to every region of mind and every form of activity. The method by which we obtain the simplest manual skill is the same as that whereby the good citizen is fashioned; and here as there the training is only finished when the bare idea of what is to be done is instantly followed by the deed itself. The labour of

acquisition is undoubtedly vastly greater in some cases than in others, but if there be only the rudiments of a faculty to start with, no attainment is utterly to be despaired of.

Dr. Reid wrote: 'No man can show a reason why our doing a thing frequently should produce either facility or inclination to do it. The fact is so notorious, and so constantly in our eye, that we are apt to think no reason should be sought for it, any more than why the sun shines. But there must be a cause of the sun's shining, and there must be a cause of the power of habit.' It is strange for us to read such a passage now. What seemed to Reid so mysterious as to be placed by him on a par with instinct cannot be said any longer to baffle explanation. We find a quite sufficient reason for the force of habit in the capacity of nervous matter to retain the results of frequent stimulation in structural modifications, the extreme form of which is subjectively familiar to us as indissoluble or inseparable Association. The effect of repeated exercise of the same kind is to groove channels, or form connections, in nervous matter, which render the passage of nerve force more easy in future, and thus to minimise that feeling of resistance which we know as effort. That 'inclination' should go along with 'facility' is also patent, for success is always the parent of fresh desire, and diminished obstruction to the realization of our aims is attended with a sense of satisfaction which reacts upon the motor centres.

The establishment of a Habit is a great mental and moral economy. Considering the number of things hourly to be done, we should come but badly off if we were not able to relegate the performance of numerous actions to unconscious centres, if we could not bring the whole force of consciousness to bear upon each novel task. We ought not to fear the reproach of becoming 'machines.' It is the very best thing that can happen to us. The more mental machinery, the larger our sphere of action, the greater our spiritual possibilities. This is not less true in the moral than in the intellectual region. This much indeed is true—virtues are not to be counted off on the fingers like so many books of Euclid, which may be mastered in the few years of school discipline, and the character pronounced complete. Special moral habits undoubtedly may be acquired, and evil tendencies eradicated by careful drill, but the automatism of the moral nature is pervasive, and a character that can be partitioned into its ethical qualities is not usually considered an exalted one. But whilst guarding against the vulgar confusion of propriety with ethical worth, not a word must be said against the gain of moral machinery. To *be* good requires truly a vast preliminary amount of *doing* good, and the struggles are usually attended with distress and intense self-consciousness. It would be, however, to miss the beauty of the ethical life to represent the face of Duty as troubled and anxious to the very last. The highest virtue is *unconscious* virtue; and a nature conscious of its effort and sacrifice is not only repellent, but imperfectly moral.

In entering on the subject of Moral Education in the detail, however, we pass into a region where the difficulties of the practical trainer thicken fast. It would be hard to say in which phase of mind the diversity is greater, in intellectual ability or moral disposition; but it is certain where guidance is easier. It may require very thorough comprehension of the laws of mental growth nicely to adjust the burden to the back in the varied field of intellectual acquisition; but the profoundest psychology will hardly by itself afford the insight needed for coping with the tendencies of the moral nature. There are several reasons for this. In the first place it cannot be said that Theory is here far ahead of Practice. Both Theory and Practice are in a very backward state. Although people have been disputing and preaching about Right and Wrong, and the Conduct of Life, for an indefinite period, it cannot be said that Moral Science is anything like as advanced as Physical and Intellectual Science. Again, although the Art of Instruction is still far from having reached a perfect form, the pains that have been expended upon it have certainly been far greater than those expended on Moral Discipline. This is a natural consequence of the circumstance that tutors rarely possess the entire direction of youth, their office usually being restricted to the culture of the intellect; and *moral* education requires constant drill or a watchful eye, both in and out of season. And even where the opportunity is afforded, the order of mind required for dealing with the moral nature is so far higher than that needed for merely imparting knowledge that, with the limited, not to say low, estimate of the schoolmaster's function which has prevailed hitherto, it would be surprising if the traditional methods possessed any considerable worth. To discipline the emotions and the wills of others effectually requires not merely extraordinary discernment, and the power of re-living the life of youth, but also a rare disinterestedness, which can refrain from giving effect to personal likes and dislikes, and maintain the attitude of an impartial judge and guide. So much depending on the teacher's personal qualities, it is to be feared that rules dealing with the formation of character may degenerate into lifeless precepts, and no good end be served by the endeavour to supply them.

If principles are to be laid down they must be of the broadest possible kind, and the application of them when assented to must be as flexible as possible. Now, there is one broad principle coming to be recognised in moral education, and which it is to be hoped will never be lost sight of again, viz., that the discipline must be natural and not artificial, grounded in relations that are necessary and not arbitrary. Although thus tersely expressed, the principle may not be very apparent, a slight paraphrase will show that we are going to the root of a very important subject. I postulate that education is to be thoroughly *real*. I assume that the business of the teacher is to fit the pupil to be a capable and worthy being *in this human life*. Considering the wide differences of opinion on topics that are subsumed under the term Religion or Theology, in dealing with education as a *science*, no other ground than this is permissible. If the public teacher be once allowed to overstep the limits of the *real* world, there is no possibility of coming to any general agreement on the subject of education. It is the business of the schoolmaster to see that the child entrusted to him assimilates *positive* knowledge, and is rendered capable of being an efficient member of a society whose existence is beyond dispute. Practically, he has to be made a worthy citizen, fitted to add to the world's wealth, and to contribute his mite to further the welfare and happi-

ness of humanity. What is the corollary from this? That those things must be regarded as virtues which tend to accomplish these ends, those things must be held to be vices which are likely to be impediments to the same. And the kind of discipline is strictly conditioned by these considerations. As the school is only a preparation for a *real* world, so the *kind* of discipline which will there hold him to his duty should be here employed in miniature. The good and ill fortune he will there encounter will be (so far as personal conduct is concerned with it) the infallible consequence of his conduct; so in the school, cause and effect must be equally necessary, if the school is to be, as it should be, a place of rehearsal, or a drill-ground.

(*To be continued.*)

ANSWERS TO ARITHMETICAL QUESTIONS IN THE 'SCHOLAR' FOR DECEMBER, 1884.

STANDARD III.

A. 1. 9927 + 51.
2. 60,280 + 11.
3. 94,732 + 25.

B. 1. 721,756,999,560.
2. 61,627 + 18.
3. 11,003 + 563.

C. 1. £11,795 5s. 7½d.
2. £17,070 7s. 8d.
3. £160,278 11s. 8¾d.

D. 1. £9198 17s. 7½d.
2. £184 1s. 4½d.
3. £6,990,816 18s. 0¾d.

E. 1. £909 14s. 5¾d.
2. £7 8s. 7½d.
3. £8207 2s. 10¾d.

STANDARD IV.

A. 1. 26,409 ft.
2. 6,744 lbs.
3. £534 9s. 9d.

B. 1. 1294 yds. 4 ft. 899 in.
2. 9,460,848 min.
3. £1 15s. 1½d.

C. 1. £5 17s. 0½d. + 127.
2. 3 mls. 4 fur. 33 po. 3½ yds.
3. 84 packets.

D. 1. £239,203 16s. 7½d.
2. 1,221,120 min.
3. 3,300 pieces.

E. 1. 133,947 ft.
2. 2,344,770 galls. 1 gill
3. £200 14s. 3½d.

STANDARD V.

A. 1. 22½ days.
2. £193 12s.
3. £83 14s. 6d.

B. 1. £219 0s. 1d.
2. £32 5s. 9d.
3. £342 18s. 8d.

C. 1. 44 yds. 2 qrs. 2 nls. 0 in. + 81.
2. £90 17s. 6d.
3. £204 10s. 11d.

D. 1. $1\frac{8}{15}\frac{8}{15}$.
2. $1\frac{7}{17}\frac{7}{17}$.
3. $\frac{8}{15}\frac{8}{15}$.

E. 1. 22½ mls.
2. £170 2s. 6¾d.
3. £180 6s. 7½d.

STANDARD VI.

A. 1. 480 hours.
2. 20·703125.
3. $1\frac{8}{15}\frac{8}{15}$.

B. 1. 133½ tons.
2. (*a*) $\frac{17}{178}$; (*b*) $\frac{11}{1078}$; (*c*) $8\frac{7}{8}$.
3. $3\frac{5}{11}$.

C. 1. 9 days.
2. $1\frac{1}{4}\frac{1}{4}$.
3. ·16875.

D. 1. 19½.
2. £2 16s. 3d.
3. 2s. $1\frac{5}{19}$d.

E. 1. 6⅔ days.
2. $2\frac{2}{3}\frac{2}{3}$.
3. £388,600.

STANDARD VII.

A. 1. 5 per cent.
2. £105.
3. 4s. 6d.

B. 1. 8s. 4d.
2. £216·4948...
3. $\frac{1}{2}$ or ·5.

C. 1. 20 p. c. more, and 16⅔ per cent. less.
2. 15s. 2½d.
3. £2400, 4½ per cent.

D. 1. 30 per cent.; 17½ per cent.; and 52½ per cent.
2. £50.
3. $1\frac{1}{3}\frac{1}{3}$.

E. 1. 6637 ac. 2 ro.
2. £1801 14s. 3¾d.
3. 15,800.

Publications Received.

Bell (G.) and Sons—
Bell's Books for Young Readers.

Blackie and Son—
In Freedom's Cause. By G. A. Henty.
True to the Old Flag. By G. A. Henty.
St. George for England. By G. A. Henty.
Traitor or Patriot? By Mary C. Rowsell.
The Wreck of the *Nancy Bell*. By J. C. Hutcheson.
Algebra. Part II.
Pinkerton's Trigonometry.
Bunyip Land. By G. Manville Fenn.
Menhardoc. By G. Manville Fenn.
Magna Charta Stories. By A. Gilman.

Cassell and Co., Limited—
Cassell's Modern School Copy Books. Nos. 1 to 12.

Chambers (W. and R.)—
Chaucer: The Tale of the Man of Lawe (with Notes).

Falconer (John)—
Civil Service Copy and Exercise Books. Nos. 1 to 7.

Heywood (John)—
John Heywood's Combined Writing and Rudimentary Drawing Copy Book.

Hodder and Stoughton—
There's a Friend for Little Children. By J. F. Armstrong.
The Two Sisters. By L. T. Meade.
Scarlet Anemones. By L. T. Meade.
The Story of the Life of Jesus.
Story after Story.
Cheerful Sundays.
The Children's Pastime. By Lisbeth G. Séguin.
The Spitalfields Genius. By J. Fayle, B.A.
Stanley Grahame. By Gordon Stables, M.D., R.N.
The Children's Portion. By A. Macleod, D.D.
Charity Moore.
Daisy Snowflake's Secret. By Mrs. G. S. Reaney.
The Mothers' Friend. Vol. XVI.

Hodgson (F.)—
An Introduction to Geometry. By J. Walmsley, B.A.
The State and Education. By C. H. Schaible, Ph.D., M.D., F.C.P.

Isbister (W.), Limited—
The Sixth Natural History Reader. By Rev. J. G. Wood, M.A.

Johnston (W. and A. K.)—
Johnston's Illustrations of Chemistry. Sheets No. 1 and 2 (with Handbooks).
Map of the Holy Land (with Handbook).
Eskimo Family.
The Chinese.
The Golden Eagle.

Letts, Son, and Co.—
Letts's Illustrated Household Magazine for November.

Longmans and Co.—
Readings in Social Economy. By Mrs. F. Fenwick-Miller.
Historical Biographies. By S. R. Gardiner.
Longman's Magazine for November.
Longman's Magazine. Christmas Number, 1884.

Marshall (J.) and Co.—
The Infant Action Song and Recitation Book.
Time Tables.

Midland Educational Trading Company, The—
The Albion Block Face for Infants' Schools.

Murby (T.)—
Notes on Elementary Physiography. By W. S. Furneaux.
Shaksperian Characters Delineated. By W. Weeks.
Langton's Examples in Arithmetic.

National Society, The—
The Childhood of Christ (Picture Card).

Nelson (T.) and Sons—
Primary History of England.
Intermediate History of England.
Advanced History of England.

Reeves (Wm.)—
The Peer and the Prophet.

Smith, Elder, and Co.—
The Cornhill Magazine for November.

Stewart and Co.—
History of Philosophy. By Dr. Morrell.
The Divine Interpretation of Scripture.

Stock (Elliot)—
Mottoes and Motives.

Wyman and Sons—
First Lessons in English Grammar. By S. E. Querini.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ **When a pseudonym is adopted it should be written at the end of the query, and the real name and address on a separate piece of paper.**

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Algebra.

1. ALPHA C.—Solve :—

$$1-\frac{x}{2}\left(1-\frac{3}{4x}\right)=\frac{2}{3}\left(3-\frac{5x}{2}\right)+5\frac{13}{40}.$$

(*Colenso.*)

$$1-\frac{x}{2}\left(1-\frac{3}{4x}\right)=\frac{2}{3}\left(3-\frac{5x}{2}\right)+5\frac{13}{40}$$

$$1-\frac{x}{2}\left(\frac{4x-3}{4x}\right)=\frac{2}{3}\left(\frac{6-5x}{2}\right)+\frac{213}{40}$$

$$1-\frac{4x-3}{8}=\frac{6-5x}{3}+\frac{213}{40}$$

$$120-60x+45=240-200x+639$$

$$200x-60x=879-165$$

$$140x=714$$

$$\therefore\ x=\frac{714}{140}$$

$$=5\frac{1}{10}.$$

2. INQUISITIVE.—A farmer sold on one day 2 oxen and 3 sheep for £34 10s., and 4 oxen and 5 sheep for £67 10s., and 6 oxen and 7 sheep for £100. Can he have sold all the oxen at one rate and all the sheep at one rate? (*Edinburgh University*, 1884.)

If the oxen were sold at one rate, and the sheep at one rate, and if x and y represent the values of an ox and a sheep, respectively, in pounds, then

$$\left.\begin{array}{l}(1)\ 2x+3y=34\frac{1}{2}\\(2)\ 4x+5y=67\frac{1}{2}\\(3)\ 6x+7y=100\end{array}\right\}$$

$$\left.\begin{array}{l}(1)\ 4x+6y=69\\(2)\ 4x+5y=67\frac{1}{2}\end{array}\right\}$$

$$\therefore\ y=1\frac{1}{2}.$$

$$\left.\begin{array}{l}(1)\ 6x+9y=103\frac{1}{2}\\(3)\ 6x+7y=100\end{array}\right\}$$

$$2y=3\frac{1}{2}$$

$$\therefore\ y=1\frac{3}{4}.$$

∴ The oxen and sheep were *not* sold at one rate.

3. SUBSCRIBER.—Find m in terms of n if

$$a^{m^n}=\left(a^m\right)^n.$$

(*Hamblin Smith.*)

$$a^{m^n}=\left(a^m\right)^n,$$

$$a^{m^n}=a^{mn},$$

Taking m^{th} root $\Big\}\ a^{m^{n-1}}=a^n,$

$$a^m=a^{\frac{n}{n-1}};$$

$$\therefore\ m=n^{\frac{n}{n-1}}.$$

4. MOTHER LOUISE.—Solve :—

$$x^2+y=7,\ y^2+x=11.$$

$$\left.\begin{array}{l}(1)\ x^2+y=7\\(2)\ y^2+x=11\end{array}\right\}$$

From (1), $y=7-x^2$;

$$\therefore\ (2)\qquad (7-x^2)^2+x=11$$

$$49-14x^2+x^4+x=11$$

$$x^4-14x^2+x+38=0$$

$$(x-2)(x^3+2x^2-10x-19)=0\ ;$$

If, $x-2=0$, then $x=2$.

If, $x^3+2x^2-10x-19=0$, we have a cubic equation for solution.

To eliminate the second term assume $x=z-\frac{2}{3}$.

Then, $(z-\frac{2}{3})^3+2(z-\frac{2}{3})^2-10(z-\frac{2}{3})-19=0$

$$z^3-2z^2+\frac{4}{3}z-\frac{8}{27}+2z^2-\frac{8}{3}z+\frac{8}{9}-10z+\frac{20}{3}-19=0$$

$$z^3-\frac{34}{3}z-\frac{317}{27}=0,$$

In the equation, $x^3+qx+r=0$, by Cardan's process,

$$x=\left(-\frac{r}{2}+\sqrt{\frac{r^2}{4}+\frac{q^3}{27}}\right)^{\frac{1}{3}}+\left(-\frac{r}{2}-\sqrt{\frac{r^2}{4}+\frac{q^3}{27}}\right)^{\frac{1}{3}};$$

Here, $r=-\frac{317}{27}$, $q=-\frac{34}{3}$;

Hence,

$$z=\left(\frac{317}{27\times 2}+\sqrt{\frac{(\frac{317}{27})^2}{4}-\frac{(\frac{34}{3})^3}{27}}\right)^{\frac{1}{3}}$$

$$+\left(\frac{317}{27\times 2}-\sqrt{\frac{(\frac{317}{27\times 2})^2}{4}-\frac{(\frac{34}{3})^3}{27}}\right)^{\frac{1}{3}}$$

$$=\left(\frac{317}{54}+\sqrt{\frac{100489}{2916}-\frac{39304}{729}}\right)^{\frac{1}{3}}$$

$$+\left(\frac{317}{54}-\sqrt{\frac{100489}{2916}-\frac{39304}{729}}\right)^{\frac{1}{3}}$$

$$=\left(\frac{317}{54}+\frac{1}{54}\sqrt{-56727}\right)^{\frac{1}{3}}$$

$$+\left(\frac{317}{54}-\frac{1}{54}\sqrt{-56727}\right)^{\frac{1}{3}};$$

Now, as $\frac{r^2}{4}+\frac{q^3}{27}$ is a negative quantity, all the roots are real and unequal, and Cardan's solution of a cubic equation is of little practical use. For in this case the values of z are imaginary; and although we know that cube roots of these expressions exist, there is no arithmetical method of obtaining them, and no algebraical method of obtaining them exactly. We have the roots exhibited in a form which is algebraically correct, but arithmetically of little value. (See *Todhunter's* 'Theory of Equations.')

∴ The only integral solution is $x=2$, and $y=7-x^2=3$.

5. PRÆCEPTOR.—Solve :—

$$\left.\begin{array}{l}\frac{x}{a+b}+\frac{y}{a-b}=2a\\\frac{x-y}{2ab}=\frac{x+y}{a^2+b^2}\end{array}\right\}$$

(*Todhunter.*)

$$\left.\begin{array}{l}(1)\ \frac{x}{a+b}+\frac{y}{a-b}=2a\\(2)\ \frac{x-y}{2ab}=\frac{x+y}{a^2+b^2}\end{array}\right\}$$

$$(2)\ (a^2+b^2)x-(a^2+b^2)y=2abx+2aby$$

$$(a^2-2ab+b^2)x=(a^2+2ab+b^2)y$$

$$(a-b)^2x=(a+b)^2y$$

$$\therefore y=\frac{(a-b)^2x}{(a+b)^2}$$

(1) $\frac{x}{a+b}+\left\{\frac{(a-b)^2x}{(a+b)^2}\times\frac{1}{a-b}\right\}=2a$

$\frac{x}{a+b}+\frac{(a-b)x}{(a+b)^2}=2a$

$(a+b)x+(a-b)x=2a(a+b)^2$

$2ax=2a(a+b)^2$

$\therefore x=(a+b)^2.$

$y=\frac{(a-b)^2x}{(a+b)^2}=\underline{(a-b)^2}.$

6. ALICE M. M. DUNN.—Solve:—

$1+\sqrt{1-\frac{a}{x}}=\sqrt{1+\frac{x}{a}}$ (*Todhunter.*)

$1+\sqrt{1-\frac{a}{x}}=\sqrt{1+\frac{x}{a}}$

$1=\sqrt{1+\frac{x}{a}}-\sqrt{1-\frac{a}{x}}$

$1=\sqrt{\frac{a+x}{a}}-\sqrt{\frac{x-a}{x}}$

Squaring, $1=\frac{a+x}{a}-2\sqrt{\frac{(a+x)(x-a)}{ax}}+\frac{x-a}{x}$

$1=1+\frac{x}{a}-2\sqrt{\frac{x^2-a^2}{ax}}+1-\frac{a}{x}$

$\left(\frac{x}{a}-\frac{a}{x}\right)-2\sqrt{\frac{x^2-a^2}{ax}}+1=0$

$\frac{x^2-a^2}{ax}-2\sqrt{\frac{x^2-a^2}{ax}}+1=0$

Extracting square root, $\sqrt{\frac{x^2-a^2}{ax}}-1=0$

$\sqrt{\frac{x^2-a^2}{ax}}=1$

$x^2-a^2=ax$

$x^2-ax=a^2$

$x^2-ax+\left(\frac{a}{2}\right)^2=a^2+\frac{a^2}{4}$

$=\frac{5a^2}{4}$

$x-\frac{a}{2}=\frac{\pm a\sqrt{5}}{2}$

$x=\frac{\pm a\sqrt{5}}{2}+\frac{a}{2}$

$\therefore x=\underline{\frac{a(\pm\sqrt{5}+1)}{2}}.$

7. UNITY.—Solve:—

$\frac{bx}{a}-\frac{d}{c}=\frac{a}{b}-\frac{cx}{d}$. (*Jones and Cheyne.*)

$\frac{bx}{a}-\frac{d}{c}=\frac{a}{b}-\frac{cx}{d}$

$\frac{bx}{a}+\frac{cx}{d}=\frac{a}{b}+\frac{d}{c}$

$\frac{bdx+acx}{ad}=\frac{ac+bd}{bc}$

$\frac{(ac+bd)x}{ad}=\frac{ac+bd}{bc}$

$\frac{x}{ad}=\frac{1}{bc}$

$\therefore x=\underline{\frac{ad}{bc}}.$

8. J. W. H.—Write down the coefficient of x^r in the expansion of $(1-x)^{-4}$. (*Todhunter.*)

As x and the exponent are both negative, the terms are all positive.

$\therefore$ Coefficient of x^r

$=\frac{4(4+1)(4+2)\ldots(4+r-1)}{\lfloor r}$

$=\frac{4.\ 5.\ 6\ldots(r+3)}{\lfloor r}$

$=\underline{\frac{(r+1)(r+2)(r+3)}{\lfloor 3}}$ Ans.

9. CYCLOPS.—Solve the equation:—

$\left.\begin{aligned}xyz&=231\\xyw&=420\\yzw&=1540\\xzw&=660\end{aligned}\right\}$ (*Winchester College Election, 1882.*)

Multiplying all together $\left.\begin{aligned}x^3y^3z^3w^3&=231\times420\times1540\times660\\&=7\times11\times3\times7\times3\times20\times7\times11\times20\\&\quad\times3\times11\times20\\&=7^3\times11^3\times3^3\times20^3\\xyzw&=7\times11\times3\times20\\&=4620;\end{aligned}\right.$

$w=\frac{4620}{231}=20;\ z=\frac{4620}{420}=11;$

$x=\frac{4620}{1540}=3;\ y=\frac{4620}{660}=7.$

10. UNITY.—Solve:—

$\frac{4x}{5-x}-\frac{20-4x}{x}=15.$ (*Mansford.*)

$\frac{4x}{5-x}-\frac{20-4x}{x}=15$

$\frac{4x}{5-x}-\frac{20}{x}+4=15$

$\frac{4x}{5-x}-\frac{20}{x}=11$

$4x^2-20(5-x)=11x(5-x)$

$4x^2-100+20x=55x-11x^2$

$4x^2+11x^2+20x-55x=100$

$15x^2-35x=100$

$x^2-\frac{7x}{3}=\frac{20}{3}$

$x^2-\frac{7x}{3}+\left(\frac{7}{6}\right)^2=\frac{20}{3}+\frac{49}{36}$

$=\frac{240+49}{36}$

$=\frac{289}{36}$

$x-\frac{7}{6}=\pm\frac{17}{6}$

$x=\pm\frac{17}{6}+\frac{7}{6}$

$\therefore\ \underline{x=4,\text{ or }-\tfrac{5}{3}}.$

11. F. HOLTON.—If $x^{-1}=(a-c)(b-c)$

$y^{-1}=(a-b)(b-c)$

$z^{-1}=(a-b)(a-c)$,

find the values of $x-y+z$ and $abx-acy+bcz$. (*Colenso.*)

(1) $x^{-1}=(a-c)(b-c)$

(2) $y^{-1}=(a-b)(b-c)$

(3) $z^{-1}=(a-b)(a-c)$

(1) $\frac{1}{x}=(a-c)(b-c)$

(2) $\frac{1}{y}=(a-b)(b-c)$

(3) $\frac{1}{z}=(a-b)(a-c)$

(1) $x=\frac{1}{(a-c)(b-c)}$

(2) $y=\frac{1}{(a-b)(b-c)}$

(3) $z=\frac{1}{(a-b)(a-c)}$

$\therefore\ x-y+z=\frac{1}{(a-c)(b-c)}-\frac{1}{(a-b)(b-c)}+\frac{1}{(a-b)(a-c)}$

$=\frac{(a-b)-(a-c)+(b-c)}{(a-b)(a-c)(b-c)}$

$=\frac{a-b-a+c+b-c}{(a-b)(a-c)(b-c)}$

$=\underline{0}$

$\therefore\ abx-acy+bcz=\frac{ab}{(a-c)(b-c)}-\frac{ac}{(a-b)(b-c)}+\frac{bc}{(a-b)(a-c)}$

$=\frac{ab(a-b)-ac(a-c)+bc(b-c)}{(a-b)(a-c)(b-c)}$

$=\frac{a^2b-ab^2-a^2c+ac^2+b^2c-bc^2}{(a-b)(a-c)(b-c)}$

$=\frac{a^2b-ab^2-abc+b^2c-a^2c+ac^2+abc-bc^2}{(a-b)(a-c)(b-c)}$

$=\frac{ab(a-b)-bc(a-b)-ac(a-c)+bc(a-c)}{(a-b)(a-c)(b-c)}$

$=\frac{b(a-b)(a-c)-c(a-b)(a-c)}{(a-b)(a-c)(b-c)}$

$$= \frac{(a-b)(a-c)(b-c)}{(a-b)(a-c)(b-c)}$$
$$= \underline{1.}$$

or, $$\frac{a^2b - ab^2 - a^2c + ac^2 + b^2c - bc^2}{(a-b)(a-c)(b-c)}$$
$$= \frac{a^2b - ab^2 - a^2c + ac^2 + b^2c - bc^2}{a^2b - ab^2 - a^2c + ac^2 + b^2c - bc^2}$$
$$= \underline{1.}$$

12. BOIS GILBERT.—How many different divisors will a number have which is the product of n different prime numbers? (*3rd Stage, Science and Art Christmas Paper*, 1884.)

No. of divisors (including unity and the number itself)

$$= 1 + n + \frac{n(n-1)}{1.2} + \frac{n(n-1)(n-2)}{1.2.3} + \ldots + 1;$$

$$(1+1)^n \text{ or } 2^n$$

$$= 1 + n + \frac{n(n-1)}{1.2} + \ldots + 1;$$

∴ No. of divisors (including unity and the number itself) $= \underline{2^n}$.

General.

1. E. H. COUMBE.—(1) The solution of your query appeared in our issue for February, 1882. (2) Perhaps 85 per cent.

2. R. W. PEARSON.—You will find the solution of your query in our issue for April, 1883.

3. M. R. S.—Your query was solved in our issue for November, 1882.

4. AGONISTES.—Either Knight's or Burchett's. Both are capital manuals.

5. DOUBTFUL.—As you say, the question is meaningless. The inspector evidently intends the answer to be 10, as you show in your postscript; but as half of the boys win, it is absurd to ask for the average loss of all. Further comment on the sum is ineedless, and we will not attempt its solution.

6. E. KIRK.—The rider was solved in our issue for March, 1883.

7. MAGPIE.—You will find the solution of your query in our issue for May, 1882.

8. C. S. J.—(*a*) The solution of your query (by arithmetic) appeared in our last issue. (*b*) We believe your writing will obtain full marks. (*c*) *Amner's* 'Notes of Lessons, and How to Write Them' (*Moffatt and Paige*), and 'The Handy Book of Object Lessons' (two series), published by *Jarrold and Sons*.

9. MAGISTER.—You will find the solution of your question in our last issue.

10. XMAS.—The solution given is quite correct. The second and third cases must be considered *apart* from the first. In the second case we have the rate of steaming and the rate of walking in one direction, and the rate of the tide in the other. In the third case we have the rate of steaming in one direction, and the rate of walking and the rate of tide in the other. We trust that the explanation is satisfactory.

11. T. H.—Your equation is exactly similar to that of 'Mother Louise' (No. 4, Algebra, in this issue).

12. T. R.—You will find the solution of your query in our ssue for August, 1882.

13. BRADFORD.—The solution of your query appeared in our issue for March, 1883.

14. EUPHONISM.—We should think 'Lily Agnes Best.'

15. M. G.—Apply to the nearest certificated teacher.

16. OMAI.—The Latin lessons will shortly be resumed in the PRACTICAL TEACHER. Writing is 'Good.'

17. FRIDAY.—Of course not. Who told you so?

18. SPERO.—Surely there is some competent teacher at hand. If so, go to him. It would be much the best; but if it is impossible, adopt the plan you mention. You ought not to be left to yourself. Your penmanship and composition need careful attention.

19. ENCRINITE.—You are, no doubt, aware that several important works on geology have recently been published, notably *Geikie's* 'Textbook,' *and Green's*. You will find some papers and lectures in the last ten volumes of 'Nature.' You will, of course, refer to the reports of the proceedings of the Geological Society.

20. CHEMIST.—Before analysing the beer at your lecture, we advise you to rehearse the experiment several times at home. You do not say what your object is. If you want to show the smallness of the solid residue, evaporate over a small steam bath equal quantities of beer and milk, and compare and contrast the results. To show the presence of alcohol, distil and collect the part that comes out first; blotting paper dipped in this will burn; the presence of the alcohol can also be shown by the reduction of bichromate of potash. It would perhaps be advisable to exhibit the constituents in case the analysis does not succeed.

21. APOLLO.—Write to the registrar, Burlington House, Piccadilly. A syllabus will be sent to you. You will find in it all the information you require.

22. BLADE.—For an account of winds and ocean currents, suitable for third year's pupil teachers, try *Murby's* 'Physiography,' and *Findlater's* 'Physiography.' Etymology implies the knowledge of a certain number of roots, as they are called, and the force of prefixes and affixes. A full account of all you ask will be found in Morris. See 45 below.

23. XMAS.—The certificate questions are published, and may be obtained from Messrs. Chapman and Hall, Henrietta Street, or through any bookseller.

24. MAGISTER.—Try *Hughes's* 'Standard Story Books.'

25. B. FRENCH.—Many grammars contain useful information. They are reliable enough; but they all need supplementing by lessons from some one who knows how to speak French. It is impossible to acquire a correct pronunciation from reading a book. You may profitably turn to *Cassell's* 'Lessons in French,' *De Lolme* and *Fasnacht's* 'Synthetic French Grammar' (Macmillan).

26. G. R. T.—For a manual on building construction, suitable for young pupil. See *Collins'* Series.

27. L. G. W.—Candidates who are taking second year's papers will have the usual examination, which includes both the subjects you name.

28. EDWAL.—Try *Deschanel's* 'Natural Philosophy,' Parts II. and IV. (Blackie and Co.). The syllabus is usually ready in December. It is not to be purchased until some time later. It changes but little from year to year. You can assume that the one in force will continue much as it is. The syllabus for 1884, and the questions set at Christmas, 1883, can be procured through any bookseller, price 6d.

29. URARI.—*Hewitt's* 'Colonies,' *Curtis's* 'Outline of English History,' 'Epochs of English History' (Longmans), *Curwen's* 'Commonplaces of Music,' Part B., 1s. 6d.; 'Standard Course,' 3s. 6d. Add *Jevons'* 'Primer of Political Economy,' 1s.

30. HEATHFIELD.—The syllabus is in the 'Code.'

31. FARLIGH.—Both specimens are too upright, and the strokes too uneven, the curves too flat. Practise greater slope.

32. INTERESTED.—Under Art. 79, any person approved by the inspector has a permanent qualification.

33. BELLA.—You seem entitled to it: communicate with the secretary of the National Union of Elementary Teachers, 59, Chancery Lane.

34. G. F. B.—(1) By permission of the principal. (2) 65.

35. VALE OF LLANGOLLEN.—Writing legible, but by no means elegant. It is too upright, and the letters are badly formed.

36. BRIEF.—Stiff, but legible; letters well formed. 85.

37. SILURIAN.—70.

38. J. GUILD.—This is a matter which is settled in the Council office. We have no authentic information, nor can you get any.

39. BLACKBOARD. — The title of honorary certificated teacher is new to us. Explain it, and repeat your query.

40. VOX.—We know of no small book containing what you want, but you can find enough in any good history.

41. NANCE.—We believe there is none. You will find it very helpful to read the other parts of the work : one part explains the other.

42. GRÆCA.—*Xenophon's* 'Hellenics,' by *Hailstone* (Macmillan).

43. CROMWELL.—Consult any good history.

44. TUTOR.—We dont know of an annotated edition of the English works, nor a translation of Feugère. For *Racine's* 'Esther' consult Bohn's translation.

45. R. H. D.—Turn to 'Elementary Lessons in Historical English,' by *Dr. Morris* (Macmillan), 2s. 6d. (p. 27).

46. D. E. F.—You can satisfy the conditions of ordinary mental acquirement; study when you are well nourished, not when you are faint; give the most wrapt attention possible to your work; don't attempt too much, think frequently about it afterwards. Some people find systems of mnemonics useful; we have not.

We always attend to the requests of private students. For mathematical query see Rule I.

47. GENTIL.—You must state exactly where your difficulty is, or we cannot help you. Avogadro's hypothesis is now found to be a direct consequence of the kinetic theory of gases. A full but not very easy account of this theory will be found in *Maxwell's* 'Heat,' page 316. But the law may be considered as established by the relations between the combining proportions of the elements by weight and by volume. One volume of oxygen unites with two volumes of hydrogen to form two volumes of water vapour. The weight of a volume of oxygen is sixteen times that of a volume of hydrogen, and the weight of a volume of water vapour nine times. It is reasonable to suppose that a molecule of O, and two molecules of H, give rise to two molecules of OH_2; but as two volumes of H unite with one of O, there must have been twice as many molecules of H in two volumes as of O in one; *i.e.*, that equal volumes contain an equal number of molecules at the same temperature and pressure. See 'Chemical Theory,' by *Ramsay* (Macmillan).

Repeat your equation; you have not given it correctly.

48. NO NAME.—The fable of the darkness is probably due to the long, dark winters of the northern latitudes. Cf. Hayman, vol. ii.; *Merry*, large edition; and *Gladstone's* 'Juventus Mundi,' vol. iii.

The idea of a living man penetrating the unseen world, and coming back to tell its secrets, is a figment of early poetic imagination. This natural curiosity found satisfaction in poetry.

49. T. H. C. SHAW.—What edition of *Orme's* 'Heat' are you using? On turning to the book, page 17, we find the sum you have sent worked out in full. The answer you sent is not correct, nor did you state that two co-efficients of expansion were used (page 16).

1 c.m. at 0°C becomes 1·00086 at 100°C.
and 1 c.m. at 100°C ,, 1·00092 at 200°C.
∴ 1 c.m. at 0°C ,, 1·00086 × 1·00092 at 200°C.
and ∴ 13 c.m. at 0°C ,, 1·00086 × 1·00092 × 13.
= 13·023149.

50. MACBETH.—A, 60. B, 70.

51. EDINBURGH.—The manuals by Roscoe and Fownes will be found suitable for all the examinations you name.

52. G. R. T.—Try the manual in *Collins'* series.

53. BETZ.—There is no such problem as you send on page 104 in either of Todhunter's books. Give correct reference, and repeat your query.

54. PUPIL TEACHER.—(1) Ask kindly and politely for a change. (2) How do you know you can claim anything? (3) By passing the examinations. (4) Early next year. We know of none.

55. DOCEO.—Article 12 (*d*) of the Code distinctly states:—'The class registers must be marked and finally closed *before* the *minimum* time constituting an attendance begins. If any scholar entered in the register is withdrawn from school before the time constituting an attendance is complete, the entry of attendance should be at once cancelled.' The attendances of the pupils leaving the school for music lessons *must*, therefore, be cancelled.

56. X. Y. Z.—The query you send is imperfect. Both statements are the same, viz., that the first number is $\frac{2}{3}$ of the second, and therefore any multiples of 3 and 5 satisfy the conditions. The attention of the publishers should be called to the question.

57. TROUBLESOME.—(1) The second part of your deduction was given in our issue for March, 1883, and in the proof the demonstration of the first part appears. (2) No.

58. ASSISTANT MISTRESS.—You will find the solution of your query in our issue for December, 1882.

59. SILURIAN.—The solution of your query appeared in our issue for June, 1882.

60. JOHN YARKER.—*But*, primarily a conjunction, may, like most other English words, be used as other parts of speech—*e.g.*, as preposition, adverb, and noun. In the sentence, 'The valiant only taste of death but once,' by analogy, and by reference to the preceding sentence, we think *but* clearly means *only*, *simply*, or *not more than*. As such it can only be an adverb. Had it said *very often*, *very* would have been an adverb of degree, and we are of opinion that *but* is the same. Suppose you wish to call *but* a conjunction, then you get the sentence, 'The valiant only taste of death, but they taste of death once!' The sentence is not complete; it needs the adverb *only*, to which we think 'but' is equivalent. In every sentence words must be parsed singly, and in accordance with their use. *But once* is an adverbial phrase, but *but* alone is an adverb.

61. E. J. B. and J. P., BARLESTONE.—A column standing on a pedestal 25 ft. 6 in. high subtends an angle of 45° at the eye of an observer, who stands on the horizontal plane from which the pedestal springs. When the observer approaches 20 ft. nearer to the column, it again subtends an angle of 45° at his eye. Find the height of the column, supposing the height of the observer's eye above the plane to be 5 ft. 6 in. (*Todhunter.*)

$$\text{Tan AHC} = \text{Tan (AHB + BHC)}$$

$$\frac{AC}{CH} = \frac{\text{Tan AHB} + \text{tan BHC}}{1 - \text{tan AHB. tan BHC}}$$

$$\frac{AB + BC}{CH} = \frac{\text{Tan } 45° + \frac{BC}{CH}}{1 - \text{tan } 45. \frac{BC}{CH}}$$

$$\frac{AB+20}{CH}=\frac{1+\frac{20}{CH}}{1-\frac{20}{CH}}$$

$$\therefore \frac{AB+20}{CH}=\frac{CH+20}{CH-20}.$$

$$\text{Tan AGC}=\text{Tan (AGB}+\text{BGC)}$$

$$\frac{AC}{CG}=\frac{\text{Tan AGB}+\text{tan BGC}}{1-\text{tan AGB. tan BGC}}$$

$$\frac{AB+BC}{CH+HG}=\frac{\text{Tan } 45^\circ+\frac{BC}{CG}}{1-\text{tan } 45.\frac{BC}{CG}}$$

$$\frac{AB+20}{CH+EF}=\frac{1+\frac{20}{CH+EF}}{1-\frac{20}{CH+EF}}$$

$$\frac{AB+20}{CH+20}=\frac{1+\frac{20}{CH+20}}{1-\frac{20}{CH+20}}$$

$$=\frac{CH+20+20}{CH+20-20}$$

$$\therefore \frac{AB+20}{CH+20}=\frac{CH+40}{CH}.$$

$$\left.\begin{array}{ll}(1) & \frac{AB+20}{CH}=\frac{CH+20}{CH-20}\\ (2) & \frac{AB+20}{CH+20}=\frac{CH+40}{CH}\end{array}\right\}$$

(1) $\frac{AB+20}{CH+20}=\frac{CH}{CH-20}$;

$$\therefore \frac{CH}{CH-20}=\frac{CH+40}{CH}$$

$$CH^2=(CH-20)(CH+40)$$
$$=CH^2+20CH-800$$
$$20CH=800$$
$$\therefore CH=40.$$

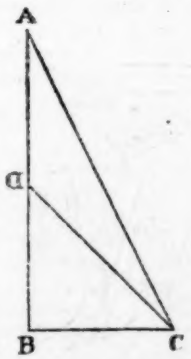
(1) $\frac{AB+20}{CH}=\frac{CH+20}{CH-20}$

$$\frac{AB+20}{40}=\frac{40+20}{40-20}$$
$$=\frac{60}{20}$$
$$=3$$
$$AB+20=120$$
$$\therefore AB=100.$$

$\therefore$ Height of column = 100 ft. Ans.

Note.—The handwriting of E. J. B. is *pretty fair.*

62. S. A. W., SMETHWICK.—The upper half of a post, seen from a point on a level with the foot of the post, subtends an angle whose tangent is $\frac{1}{3}$; find the tangent of the angle subtended by the whole post. (*Todhunter.*)



$$\text{Tan ACB}=\text{Tan (ACD}+\text{DCB)}$$
$$=\frac{\text{Tan ACD}+\text{tan DCB}}{1-\text{tan ACD. tan DCB}}$$

$$=\frac{\frac{1}{3}+\frac{DB}{BC}}{1-\frac{1}{3}.\frac{DB}{BC}}$$

$$\therefore \frac{AB}{BC}=\frac{BC+3DB}{3BC-DB}$$

$$\frac{2DB}{BC}=\frac{BC+3DB}{3BC-DB}$$

$$2DB(3BC-DB)=BC(BC+3DB)$$
$$6BC.DB-2DB^2=BC^2+3BC.DB$$
$$BC^2-3BC.DB=-2DB^2$$
$$BC^2-3BC.DB+\left(\frac{3DB}{2}\right)^2=\frac{9DB^2}{4}-2DB^2$$
$$=\frac{DB^2}{4}$$
$$BC-\frac{3DB}{2}=\pm\frac{DB}{2}$$
$$BC=\pm\frac{DB}{2}+\frac{3DB}{2}$$
$$\therefore BC=2DB, \text{ or } DB.$$
$$\therefore \text{Tan ACB}=\frac{2DB}{BC}$$
$$=\frac{2DB}{2DB}, \text{ or } \frac{2DB}{DB}$$
$$=1, \text{ or } 2.$$

Arithmetic.

1. IMPATIENT.—Find the difference between the simple and compound interest of £150 at 4½ per cent. per annum for 3 years. (*P. T.'s Examination*, October, 1884.)

£
150
9
2 | 1350
675
3
£20·25 Simple interest = £20 5s.
20
s. 5·00

£
150
9
2 | 1350
£6·75

£
156·75
9
2 | 141075
£7·05375

£
163·80375
9
2 | 147423375
£7·37116875

£
150
6·75
156·75
7·05375
163·80375
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2. JERRY.—A boat's crew row over a mile and a quarter against a stream, which flows at the rate of 2 miles an hour, in 10 minutes. The usual rate of the stream is half a mile an hour. Find the time which the boat would take in the usual state of the river. (*Hamblin Smith.*)

They could row $(2-\frac{1}{2})$ miles or 1½ miles more in an hour in the usual state of the river
= ½ of 1½ miles in 10 minutes
= ½ of a mile in 10 minutes;
miles miles min.
$\therefore 1\frac{1}{2}+\frac{1}{2} : 1\frac{1}{2} :: 10 : \text{Time.}$

$$=\left(\frac{5}{4}\times\frac{10}{1}\times\frac{2}{3}\right)\text{min.}$$
$$=\frac{25}{3}\text{ min.}$$
$$=8\tfrac{1}{3}\text{ min.}$$ Ans.

[*Owing to the great pressure on our space a large number of Queries are held over.*]

The Practical Teacher.

A MONTHLY EDUCATIONAL JOURNAL.

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The numbers of the *Practical Teacher* for February and March, 1884, are now out of print.

Matriculation Hints.

BY HENRY A. REATCHLOUS, M.A. (LOND.), B.Sc.,

Westminster Training College.

THE subject of Hydrostatics often presents peculiar difficulties. There is no royal road through them. The student must try to think patiently, clearly, and attentively. The books previously named contain all that is necessary, and some of them much more. There is also a cheap manual by Galbraith and Haughton, one by Magnus, and the well-known text-book by Besant (Bell and Co.). The first, and perhaps most important, point is to get a correct notion of how pressure is transmitted in a liquid and a gas, and how it varies as with the depth. If a be the area of the base of any vessel, h be the height of the liquid, ρ be the density of it, and g be acceleration due to gravity, then the pressure on the base will be $a\,h\,\rho\,g$ dynes, or $h\,\rho\,g$ dynes per square centimetre. Sea-water has a pretty constant density, and a pressure guage submerged at a constant depth would, by giving us the dynes per square centimetre, afford us a means of comparing the different values of g for different latitudes. No notice was taken of the pressure of the air, which, when the barometer is at 760 mm. is equal to 15 lbs. on the inch, or 1,033 grams per square centimetre, or 1,033 981 dynes per square centimetre. Hence, if this is added, the pressure at any depth of a fluid is $1{,}033\times 981 + h\,\rho\,g$ dynes per square centimetre.

Suppose a body is floating, partially immersed in water. The other part is immersed in air. The apparent loss of weight of the body is due to the water displaced and the air displaced, the former being, of course, very much the greater of the two. What would happen, then, if a beaker containing a ball floating in water be put under the receiver of an air-pump, and the air exhausted? Obviously the ball would tend to sink; more of it would be immersed in the water.

The syllabus mentions specific gravity, and modes of determining it. The student is specially recommended to determine for himself the specific gravities of a few substances. Take, for instance, a penny; weigh it in air, and then suspend it by a thin wire or fine thread to one scale-pan of a balance, and immerse the coin in pure water. Now weigh it again. The loss of weight is the weight of an equal bulk of water. Hence the specific gravity of the coin $= \dfrac{\text{weight of coin in air}}{\text{weight of equal vol. of water.}}$ This result, however, needs correction, as the weight of a definite volume of water varies with the temperature. A correction can be made. It is only at 4° C. that the density of water is unity. The temperature of rooms we work in varies from 12° to 20° C. The weight of the equal volume of water is, therefore, a little too small. The density of water at different temperatures has been carefully observed and recorded. If the thermometer stands at 15° C., and the loss of weight in water is 9·9915 grams, the weight of that volume of water at 4° C. would be $\cdot 99915 \times \dfrac{10000}{9915} = 10$ grams.

We give the density of water for the temperatures between 14 and 20. At 14° it is ·99930; at 15°, ·99915; at 16°, ·99915; at 17°, ·99884; at 18°, ·99866; at 19°, ·99847; at 20, ·99827. For perfect accuracy, the weight in air should be reduced to the weight in vacuo, by adding to the weight in air the weight of the air displaced by the body, and subtracting from the sum of the weights used the weight of the air displaced by them.

The presence of the air may be neglected in all ordinary cases, as it would only affect the second place of decimals.

A substance like cork or paraffin should then be taken, and a sinker employed.

Suppose a body is acted upon chemically by water, some other liquid must be used. Thus a piece of sodium weighs, say, 10 grams in air, and 1·8 grams in naphtha, of specific gravity ·8. The weight of an equal bulk of naphtha is therefore 8·8 grams; but an equal bulk of water would be $\frac{8\cdot8\times10}{8}=11$. Hence the specific gravity of sodium would $\frac{10}{11}=\cdot9$.

Now take a specific-gravity bottle. It should be be quite clean and dry. It can be cleaned with a little acid, or if greasy, with a little soda. It can be sufficiently dried by warming it, and blowing into it, from a pair of bellows, a stream of air. Weigh the bottle; fill it with distilled water and weigh it again. The weight of the water can thus be obtained. Rinse the bottle out several times with alcohol, and then fill it with that liquid and weigh it again. The weight of the alcohol can then be found. The ratio of the weight of the water to that of the alcohol is the specific gravity of the latter.

With a specific-gravity bottle we are able to find the specific gravity of small fragments of substances. Suppose the weight of the bottle is 25·7 grams, and the weight of the water it contains at 4°C. is 64·85 grams. Put 43·75 grams of shot in the bottle, and then fill it up with water. Suppose the weight of the bottle, shot, and water is 130·35 grams; which, less the weight of the bottle, is 104·65 grams. The loss of weight of the shot in water is obviously

$$64\cdot85+43\cdot75-104\cdot65=3\cdot95.$$

The specific gravity of the shot is

$$\therefore\frac{43\cdot75}{3\cdot95}=11\cdot29.$$

If the student has a Nicholson's Hydrometer, he can find with it the specific gravity of a liquid and a solid. The presence of air-bubbles will interfere with the accuracy of the results. These must be removed. Water recently boiled is the best to use. It will, of course, have occurred to the student that as a body loses, when weighed in water, the weight of an equal volume of water, this furnishes an easy method of finding the volume of bodies which are awkward to measure Thus we can ascertain the volume of an irregularly-shaped mineral, or a piece of copper-wire. Knowing the volume of the wire, and its length, its cross-section can be at once obtained by dividing the former by the latter. Its radius can be then deduced.

There is a very simple way of obtaining the specific gravity of liquids by weighing, say, a piece of glass in them and in water. The object is first weighed in air, then in water, and then in the liquid whose specific gravity is to be determined. If it weighs 34 grams in air, and 20 in water, and 10 in the liquid; the specific gravity of the liquid

$$=\frac{\text{loss of weight in liquid}}{\text{loss of weight in water}}=\frac{24}{14}=1\cdot7.$$

Further, if a glass tube, not too narrow, be bent into the shape of a U-tube, and water be poured into one limb, and oil or mercury into the other, when there is equilibrium the specific gravities will be in the inverse ratio to the heights of the fluids. This will be so, whether the tube be of uniform bore or not, a very important result, especially in relation to the method for obtaining the absolute coefficient of expansion of mercury.

(*To be continued.*)

—o—

Publications Reviewed.

PRIZE BOOKS.

MESSRS. BLACKIE AND SON'S LIST.

First Notice.

THE above publishers have sent in the following beautifully-bound, nicely-printed, and, in some respects, well-illustrated volumes.

They are all more adapted for boys than girls, being tales of adventure and heroic daring and enduring. Two of the parcel are fictions; two are collections of true stories; and the remaining volume is a combination of fact and fiction.

The teaching is rather moral than religious, but perfectly healthy and trustworthy. To treat them singly:—

(1) Robinson Crusoe.

We must not pass this work over by simply calling attention to it as another edition of this marvellous work, and remarking on the pictures by Gordon Browne, which are numerous and fairly reproduced, and the general appearance of the volume as attractive, etc., etc. Messrs. Blackie and Son have here reprinted the original work as it was issued to the English reading public in 1719. They assure us in their preface that 'no attempt has been made to polish the strong, unstudied diction of the author, or to improve on his homely, vigorous language.' True, they have very properly omitted some gross and profane expressions which were felt to be 'superfluous to the text,' and have corrected the spelling of a few geographical names, but, with these exceptions, we are assured we have the book as it was intended to be read by the author himself.

There is a short but interesting account of the first edition—of its success and how it gave rise to the second volume, or part, published under the title of 'The Farther Adventures of Robinson Crusoe, being the second and last part of his life, and strange, surprising accounts of his travels round three parts of the globe. Written by himself.' This introduction also tells us of a third part, called 'Serious Reflections by Robinson Crusoe,' which never became popular, as it had no real connection with the history of Crusoe.

There are some six pages devoted to the account of 'the man who wrote Robinson Crusoe,' which are well worth reading, as they tell us of De Foe, not only as a writer, but as a politician. No boy will be surprised to read that the author of Robinson Crusoe was a man of indomitable pluck, for who but such could conceive so wonderful a chain of events, in which pluck carried all before it?

We are distinctly warned that we must not expect to be able to parse according to modern theories all the sentences we find in the mouths of the characters who speak in the course of the narrative; and this, we are assured, is owing partly to the fact that the rules of grammar have somewhat changed, but more from the fact that De Foe was too good a story-teller to make an uneducated person talk too well.

(2) The Pirate Island. By Harry Collingwood.

This is not by any means Mr. Collingwood's first story for boys; we expected, therefore, a treat, and, let us say at the very outset, we got it.

The first two-fifths of the book or so are very like the majority of these boy books, which tell us of the sea and sailors. We have no less than three shipwrecks, told with a certain amount of detail, and a fourth referred to. On board the ship, to whose loss reference is made, there was found a baby, the sole survivor, well dressed in

linen all duly marked. This lad is brought up by a fisherman, and figures conspicuously in the first of the three shipwrecks. This brings him under the notice of the captain, who, eventually, takes him to sea; but before he sails with this new friend he takes a few trips on a collier, of which he sees the last, as he and the rest of the crew only just save themselves before she founders.

His first voyage to Australia, as an apprentice, is very successful and uneventful. From Australia they bring one of those extraordinary men, of whom, no doubt, there are examples, who can pretty well do everything. Though a military engineer by profession, he had planned and had constructed for himself a wonderful yacht which could perform marvels; in addition to this we find he has sufficient surgical skill not only to set, but even to amputate limbs. He, though not so called, is the real hero of the story, and being, withal, a very modest, self-contained man, is a charming companion, and one of whom we do not tire.

On their homeward voyage, the ship is discovered to be on fire, and, eventually, has to be abandoned. The captain, his wife, and little daughter, two lady passengers, three other passengers, and the apprentices, including the foundling of the wreck, are in the only boat which is saved: they are picked up by a pirate, and eventually landed on the Pirate Island, where they are made to work. Up to this point the story has kept along well-known and often-used lines, but here we have what may be called a new departure. We naturally then read this part of the book with more interest and curiosity. The wonderful passenger now begins to utilise his exceptional knowledge and powers. He builds a schooner, raises a fort, discovers mineral treasures, and acts as doctor. Of course, the excitement of the story consists in the solving of the question as to how they are to get away from their bondage. We are not going to tell how they effected this, beyond the fact that the denouement is brought about by our apprentice lad. On their arrival in England this lad's parentage is fully established, and all ends happily. We are promised at the end an account of the expedition (should it come off) which is being organised, to secure the mineral wealth of the island.

(3) Stories of the Sea in Former Days.

We are not told who the editor or compiler of these stories is. They are described on the title-page as 'narratives of wreck and rescue,' and we are assured that they are the accounts of actual facts 'compiled from authentic sources.'

There are no less than nine of them placed in chronological order, beginning with the adventures of Pietro Quirini, a Venetian (1431), and ending with the loss of the *Nautilus*, (1807). That boys love dearly to read *true* stories, no one can doubt, and—we all are far more lastingly moved by the account of a fact, however badly told, than by a fiction, however graphic; still we cannot help thinking that the editor or compiler might have done a little more than he has done, in preparing these histories for the press.

The stories are generally told in the form of narratives, by one or more of the actors in the scenes described. Sometimes these accounts do not quite agree, and we are left to form our own opinion. Now this may be all very well for men, but boys want things told them very plainly and in a matter-of-fact way. That wonderful history, the 'Mutiny of the Bounty,' which its sequel on Pitcairn's Island has made so familiar to the English-reading public, is here by no means particularly interesting.

No doubt, Christian's conduct was unjustifiable, though Lieutenant Bligh's was as aggravating as it could be, yet boys don't care to read counter-statements; what they want is to be able grasp the facts as they occurred: the lessons to be learnt from them will come by-and-bye. The fearful tale of the sea the newspapers have been lately unfolding to us may, perhaps, convince some, of the possibility of all that is told us here, of which, without such immediate corroboration, they might have been sceptical.

(4) Adventures in Field, Flood, and Forest.

Here, also, we have no editor's name mentioned, but are again assured that these stories of 'danger and daring are wholly founded on the real experiences of those who figure in them.' Though published before, the editor believes that the books whence they are taken are so out of the reach of general readers that the collection is practically almost a new one.

There are no less than twenty-one of these sketches. The second and third are entitled, 'The True Story of Alexander Selkirk' and 'The French Robinson Crusoe.' We have stories in New Zealand, Australia, amid the ice off Newfoundland, and the last but one is entitled, 'How an Irish Sailor became King in New Guinea.' The account how Sabinade Steinbach completed the Cathedral of Strasburg is perhaps, the best.

(5) Brothers in Arms. A Story of the Crusades. By F. Bayford Harrison.

Here we have a combination of fact and fiction. Amidst all the historical personages of the Third Crusade, two lads are introduced. They follow the fortunes of the lion-hearted king, and get mixed up in a very interesting way with the vicissitudes of the expedition.

That boys in this way read and learn a vast amount of history, no one can doubt. In these high-pressure days the tendency is to compress history into the barest string of events and dates. Such stories as these may add a little flesh to the dry bones of fact, so as to make the task a little less unwelcome.

The lads introduced here are interesting and courageous, and such as to excite the admiration of youthful readers, and there is evidently a denouement to be told at the end of the book which keeps the attention on the alert throughout.

Second Notice.

THIS second parcel, though equally attractive in appearance to those already noticed, is one of a very different class of books.

With one exception, these are stories in which many historical personages figure, and might be termed historical story books.

(1) The Wreck of the Nancy Bell; or, Cast Away on Kerguelen Land. By John C. Hutcheson.

This is the one exception to which reference has been made, being a story of shipwreck, etc., in which the characters and events are the creations of the author's brain. It is a book after a boy's heart, in which adventure follows adventure, as fast almost as one can turn over the leaves. Well-nigh everything that can happen to a ship on her way from the north to the south, does happen. They witness a fatal fight between a whale and a thresher; they pick up a small boat with several dead bodies and one just alive; they experience all the horrors of a cyclone; they endure an agony of suspense by discovering a fire in the hold; and so on, until the wreck comes.

The ship being a passenger ship, we have, amongst others, an old lady to afford amusement; a young one to sympathise with, in her love affairs; an imp of a boy to follow in his mischief; and a too-Yankee Yankee.

The captain is genial—well backed up by an intensely Irish first mate; and, as a barque of this kind would be altogether wanting if there were no coloured man on board, here we find him; but we must, at any rate, congratulate Mr. Hutcheson on the sable gentleman's manner of entrance on the scene.

We can promise any boy, lucky enough to get hold of this work, a great treat, and heartily recommend it to all prize-givers.

(2) Traitor or Patriot? A Tale of the Rye House Plot. By Mary C. Rowsell.

The hero of this pretty story is a young yeoman, living close to the celebrated Rye House. He is in love with

the pretty daughter of the old miller who was its occupant, and through her gets to know of the secrets of the traitors. At first, however, we find him to a certain extent implicated in the conspiracy—hence the title. A charming subterranean passage, so dear to a boy's heart, exists between the Rye House and the hero's home, which is utilised in the course of events.

The tone of the book is healthy, and the style graphic; and we wish it all success.

(3) **True to the Old Flag.** A Tale of the American War of Independence. By G. A. Henty.

Mr. Henty evidently feels his mission is to teach lads history, under the guise of fiction. We have no less than three of his efforts in this line before us, and the title-pages tell us of others he has given to the world previously.

He assures us in his preface, that justice has not been done to the bravery of the English, in that lamentable war which she so unrighteously waged with her N. American Colonies some hundred years ago. We were worsted, as we were bound to be, and we therefore keep silence in the matter. The Colonists were victorious, and they tell their story from their point of view; and who, under these circumstances, can be astonished that the English are not represented as being all that they might have been, and, in fact, in many instances, all that they were?

In reading history nothing is more important than to know by whom and for whom the history was written, if we would rightly judge of the authenticity of the facts and the correctness of the opinions to be gathered.

If English boys learnt their histories of Mary and Elizabeth from accounts written by Roman Catholics for Roman Catholics, would they have the opinions they now have of these two queens? Have not boys now a very different notion from what boys a hundred years ago had of the respective characters of Charles I. and Cromwell since historians have dared to examine facts with clearer glasses? Mr. Henty here shows us that, though the English arms were repulsed, yet there was no less bravery and loyalty than in those campaigns where all was success and honour.

The first few pages of the book are devoted to a description of what the backwoods settlers had to contend with in the raids of the Indians, after which we follow a lad, who, though born in the country, had volunteered on the king's side, together with his father (a retired English officer), from Lexington and Bunker's Hill to the surrender of Cornwallis.

Mr. Henty has taken great care in collecting his facts not to mislead, and intersperses his narrative with trite criticisms on the accounts given by the other side. A boy would have a very fair knowledge of the history of this important struggle if he could pass an examination in the volume before us.

(4) **St. George for England**: A Tale of Cressy and Poictiers. By G. A. Henty.

The same author here would waft his many boy-readers back some four centuries to learn of Cressy and Poictiers and the many brave doings of the Black Prince. The hero of the story, who appears as a prominent figure in the stirring events, is brought to London as a child by his mother, and, on her death, left in the hands of her old nurse and her husband, who bring him up as their son. He is apprenticed to an armourer, who teaches him not only how to make arms, but to use them. As a lad he had been noticed by the Black Prince, then a child of ten, and later on, the king himself, when present at the city sports, says a few kind words to him, when he receives the first prize for fencing.

An accident enables him to prevent the successful carrying out of a wicked plot to run down a boat on the Thames, and thus kill a good lady and her young daughter.

The author of this plot is the villain of the book, who never ceases to persecute our hero, until at last, after being outlawed and disgraced, he is slain in open conflict, when serving with the enemy. The history is carefully given, and the character of the Black Prince faithfully pourtrayed.

In conclusion, we do not know where we have met with a more fascinating story, nor with so successful an effort to combine history with fiction.

(5) **In Freedom's Cause**: A Story of Wallace and Bruce. By G. A. Henty.

Here Mr. Henty, with the same power which he has shown in the other works we have referred to, has gone into still remoter times, and tells his readers of how Scotland freed herself from the domination of England. In his preface the author acknowledges the labours of Mr. W. Burns in his work, 'The Scottish War of Independence,' as the source of his historical facts. As in 'St. George for England,' the events which preceded and led up to those in which the hero figures are carefully narrated to him by one of the characters, so as to enable the reader, if he forgets his history, to understand what is happening.

In conclusion, we cannot but think that others than lads are much indebted to Mr. Henty for these admirable tales, and we wish them all success, feeling sure that they will render very pleasant what is only too often considered a disagreeable task.

MESSRS. HODDER AND STOUGHTON'S PUBLICATIONS.

Second List.

(1) **The Story of the Life of Jesus.** Told in Words Easy to Read and Understand. By the author of 'The Story of the Bible.'

The author here has set herself no easy task, viz., to change the words of the narrative of our Lord's life from what we have in the Bible.

Bible language is so simple that we doubt if children can understand any modification of it one whit the better. We know of no life of Christ that does not send us back to the Biblical narrative unsatisfied and disappointed. It may be something to have the four stories welded into one, but even little children in hearing an account of a story they know from a second evangelist, are pleased to note where the accounts agree, and where they differ, as every infant schoolmistress could vouch for.

The story, too, is constantly interrupted by such efforts to teach as we find in the following extract.

In the chapter on the temptation in the wilderness we read:—

'Whenever Satan is going to tempt any person to do wrong he finds out what thing it is that person wants most. Then he tries to make him do wrong to get that thing. He knew that Jesus had fasted and wanted food, and he thought he would make Him do wrong to get it.'

There are forty full-page illustrations, in which the face of Jesus is the most unconventional one we ever saw. The landscapes are far better than the figure pictures, the latter being anything but good. The one that represents Jesus before Pilate is exactly that of a man with his hands behind his back, examining carefully a marble statue of a sitting figure.

(2) **The Children's Portion.** By Alexander Macleod, D.D.

The author tells us that this title ought to be filled out into the 'Children's Portion in the Sunday Service,' being, in fact, the short sermons addressed to the children on Sunday mornings. Their language is simplicity itself, and the manner affectionate. They would be very suitable for Sunday evening reading to children, when unable to go out to a place of worship.

(3) **There's a Friend for Little Children.** A Story. By Jessie F. Armstrong.

This is a very pretty little story told by one who loves children, and wishes to make them good.

There is a child-loving clergyman, and a good wife of a gamekeeper, who teach admirable lessons.

The pictures are charming, being drawn in outline. This would be an admirable prize for a little child who has just learnt to read.

(4, 5) **Scarlet Anemones**, and **The Two Sisters.** By L. T. Meade.

These are two little tales. The former is more suited for young children—the moral being the harm of deceit and the misery it brings with it. The latter deals with older people, and is more adapted for bigger girls. The lesson to be learnt is the beauty of self-sacrifice, which here we find duly rewarded. The authoress' word-painting of scenery is admirable, as well as her development of character. As prizes we fear they are too small for the class of children to whom they should be given.

Plant Life. By Edward Step. London: T. Fisher Unwin.

That this little volume has reached already its third edition is more disappointing than encouraging to the lover of accurate science. The only encouragement to be derived from the fact is in the knowledge that there is a reading public anxious to be told in popular language truths about nature. But accuracy must not be sacrificed to popularity. Inspired by this sentiment, let us at once say that, despite the reaching of a third edition, Mr. Step's book is a very bad one.

Dedicated to the officers and members of the Lambeth Field Club, 'Plant Life' is a witness to the good and to the danger of these Natural History Clubs. It bears testimony to the love of Nature, the increased facilities for and power of observing natural phenomena, the wider knowledge, that these organisations foster. But it also warns us of the tendency to slipshod science, loose-thinking, inaccurate expression, that so frequently results when the little knowledge that is proverbially 'a dangerous thing' has been acquired.

Fourteen chapters and 156 illustrations are devoted to the account of certain plants and certain special phenomena of the vegetable world. Of system there is none whatever, and in his appendix Mr. Step gives as his reason (not only for want of system, but actually for violations in his grouping of the systematic arrangements in common use) this—that he is writing for the non-scientific student! It is when we are writing for the non-scientific student that, without any undue forcing on his notice of classification terms, he should by reading of plants or animals in their natural—*i.e.*, phylogenetic—sequence, learn unconsciously classification itself.

One minor consequence of this unsystematic treatment of the subject is that we find Mr. Step occasionally repeating either one of the many authors quoted by him (pp. 123, 162), which is bad, or repeating himself (pp. 122, 158), which is worse.

Before dealing with the serious errors of the book, let us say a word or two as to Mr. Step's style. That is fairly clear. One can follow, as a rule, his statements. This makes it the more matter for regret that the statements are so frequently inaccurate. Our author is also, we should think, a bit of a humorist in the family circle. The insects, *e.g.*, drowned in the pitchers at the base of the leaves of the Tree-pines are 'overtaken in their cups.' The epiphytic orchids are 'without any visible means of subsistence.' Fainter gleams of the same rollicking fun are to be seen when the insects are spoken of as persisting in committing suicide, and its last outburst occurs on p. 202, seven pages from the end. The subject is the egg-cases of the dog-fish, commonly known as mermaids' purses. Mr. Step *loquitur*. 'We do not believe they are possessed of pockets wherein to keep them if they had them.' The humour here is somewhat obscured by the vague use of personal pronouns to which the writer is given; but there is enough of it to show us the nature of the elephantine fun and banter with which we do not doubt Mr. Step is wont to set the Lambeth Field Club 'on a roar.'

Another peculiarity of style, and one for which we may be grateful, is the author's habit of making multitudinous and lengthy quotations. The book is as full of these as the play of 'Hamlet' was, according to the gentleman who saw it for the first time. In the quotations he displays a large-minded nature. Charles Darwin and the *Daily News*, *e.g.*, are laid under contribution, and the metrical quotations range from the poetry of Shelley to the verse of Mrs. Hemans. The worst effect of these almost innumerable extracts from the writings of others is that, like jewels in a common setting, they show up the want of finish in their surroundings.

As to the matter of the book, we may at once say that, but for the many mistakes in its science 'Plant Life' would be a useful volume for the lonely microscopist, far away from books of reference and from more skilled friends. It will be a help in identifying certain less-known plants, either under the microscope or in the fields. Further, some of the practical hints are excellent. The construction of a fernery out of very simple and inexpensive materials, the advice to fern-collectors (p. 166), and that to the searchers after Fungi (p. 196) are of this kind. The fact that Mr. Step gives due attention to the Cryptogams must be noted and commended. The account of predatory plants that are not as familiar to the ordinary reader as the sundew or the fly-trap is another instance of good work.

Again Mr. Step has read wisely, as far as the selection of authors is concerned. Thus Darwin is frequently quoted, though it is to be regretted that, in the reference to his works on the movements of plants on p. 6, only the early work, 'The Movements and Habits of Climbing Plants,' is mentioned. Nothing is said of the later—and as far as botany is concerned the last—work of the master, 'The Power of Movement in Plants.' This was published in 1880; the book under review is already, as we have said, in its third edition. Culpeper has also been well studied by Mr. Step, and we are charmed to see, from p. 106, that he has read delightful Thoreau.

But with this, commendation must end. Whether we consider Mr. Step's English, or his chemistry, or his physics, or his botany, the verdict has to be 'bad.' English first. He begins early. On p. 7 we have: 'This is the *Volvox globator*, a species that once puzzled scientific men considerably to assign the department of Nature to which it belonged.' Fourteen pages later occurs the following: 'But besides these zoospores and simple spores, the potato fungus produces a third kind called 'Oospores' which *were* unknown until Mr. Smith's careful study of the fungus by night and day, through its various changes and developments, revealed *its* existence. On p. 31, 'albuminoids, of which protoplasm itself is formed, and is dependent upon for growth and increase.' On p. 100, 'This case is botanically termed a sporange, and the clusters of them are spoken of as a sorus.' But the pronoun 'it,' is Mr. Step's chief stumbling block. It trips him up again and again. Here he has the attack in a comparatively mild form. 'The chlorophyll—bearing cells have the power of retaining the carbon, and setting the oxygen free; but *it* can only do so when under the influence of sunshine.' Here is a more virulent case: 'The protoplasm of the cells is thickly dotted with grains of starch, *it* being laid up in the tuber to provide nourishment for the new shoots (eyes). In the wheat, oat, rice, pea, and bean we find *it* stored up in the seeds, for the nourishment of the young plant or embryo whilst *it* is developing *its* roots and leaves.'

We are not quite sure, whether Mr. Step is a genuine believer in the doctrine of evolution, though we have our

suspicions. Whether he is or not, one passage at least in his book is illustrative of the doctrine. Everyone knows that the evolutionist is always on the look-out for transition forms. 'Plant Life' presents a very interesting case of gradation between bad English and bad botany (p. 35): 'If both are found on the same plant, they are monœcious.' 'Both,' it may be said, has reference to stamen and carpel flowers; but 'they' has reference, not to the stamen and carpel flowers, but to the plant as a whole on which they occur. Here is a sentence, therefore, that might be given to an examinee in English for correction, and that even taken at its best—and bad is the best—contains a blunder in botany.

Nor is the badness of the construction atoned by excellence of idea. It is true that on one occasion Mr. Step tries to be artistic, and only succeeds in being high-flown. Take his ambitious attempt at description of ferns and their habits and habitats, on pp. 95 to 98. It has periodical descents into baths, marked by such words as 'sifted,' 'wriggled,' 'percolating,' and by the injunction to carry the ferns home 'tenderly by the roots.' Or notice again, on p. 116, Mr. Step's benigning of the fairies, if we may coin a word. Everybody but Mr. Step knows that the fairies are called 'the good people,' for propitiation's sake, and not because the country folk think them really good. This method of naming is the same as that used by the Greek when he called the Furies 'Eumenides' (ευμενης=gracious), and by the Latin when he called the Fates *Parcæ* (*parco=I spare*). Yet the author of 'Plant Life' talks of the fairies as 'always performing good deeds.' This is what we call benigning them—a process better than maligning, but not so good as the truth. The fact is that Mr. Step knows no more of the fairies than of botany or of Latin.

Of this latter language we should hardly judge the member of the Lambeth Field Club to be a master, or even a scholar. He speaks (p. 110) of the 'stipoides' of the ferns, not knowing that the plural of '*stipes*' is '*stipites*,' and on p. 158 he gives a quotation from Culpeper that is certainly bad Latin: '*E cenum Mars solus habet.*' We should think the blunder is that of the transcriber, rather than the old enemy of the College of Physicians. We may be unjust to Mr. Step in our estimate of his Latin knowledge. But when the only two classical words or phrases he uses are inaccurate, we are entitled to give him the benefit of our doubt. As he himself might have written, *Ex unum disce omnes.*

From language blunders let us turn to scientific blunders. Some of Mr. Step's sins are mere matters of carelessness; others are of a more serious nature. Of the former kind is the calling the Algæ a tribe, and the Fungi a family, and this within the limits of a single paragraph. The blunder is twofold. For, in the first place, neither of these groups is either a tribe or a family, and in the second, whatever the one is, that the other is; that is to say, the group fungi and the group algæ are of similar significance. Never were there two groups in all our many artificial systems of classification so parallel one to the other as the fungi and algæ; and to name them with different names, as 'tribe' and 'family,' is to betray an ignorance of botany that is scarcely in harmony with book-writing.

Other examples of carelessness are 'protoplasm covered with chlorophyl,' the statements that wood consists of cellulose (as if the substance of the original cell-wall underwent no change in becoming wood); that Mucor is unicellular (we know that Huxley and Martin are responsible for this error, that has been copied by every embryonic biologist since); that stomata are breathing-pores (made on p. 19, contradicted on p. 28); that flowers have stamens and pistils (the parallelism is between stamen and carpel, or andrœcium and pistil); that fovilla is protoplasm (without any mention of its starch and oil); that the pollinia of orchids alter their position, after removal from the flower because of their weight and the slenderness of their stalks (no mention being made of the contraction of the membranous piece of the rostellum that is detached with them). Along with these instances of carelessness may be taken the absence of all attempt at giving the derivation of technical words; the utilisation of English measurements, and not of the decimal system; and the constant use of the dangerous phrases 'in order to,' 'for the purpose of.' The careful biologist is especially careful not to commit himself or Nature by expressions of this kind. He is content only to record facts.

But Mr. Step is far worse than a merely careless writer. He is an inaccurate writer. As we have said, his chemistry, physics, and botany are alike at fault. When, 'quite early in the volume,' we found him talking about carbonic *anhydride*, a dread fell upon us. The gloom of it deepened when the old artificial distinction between the organic and the inorganic was directly after insisted upon. Let us, as Mr. Step suggests, turn to a very clever chemist, and ask him what he thinks of the distinction mentioned above, and evidently credited by the author of 'Plant Life.' We turn to Professor Schorlemmer, one of the first of European chemists: 'To-day we know that the same chemical laws rule animate and inanimate Nature, and that any definite compound produced in the former can be prepared by synthesis as soon as its chemical constitution has been made out.'

The gross ignorance (we fear we can use no other adjective) of chemistry that is the unhappy possession of Mr. Step will be gathered from the following instances. Salts are said to contain potash; the carbon of carbon dioxide 'mixes' with the liquid food of the plant; nitrogen and sulphur are taken up by the roots (all these blunders are on one page—p. 30); potash and magnesia are stored up in the cells (p. 32); binoxalate of potash is mentioned; Protococcus is said to absorb carbon. Nor is this last tremendous statement a slip, as we might at first imagine. It is repeated on pp. 32, 124, 180. The passage on p. 124 is too delicious not to be quoted: 'The plants consume the poisonous carbon with which the respiration of animals has polluted the air.'

Mr. Step is as bad a physicist as chemist. He gives, as one of the conditions necessary for the growth of plants, '*heat* above the freezing point.' The italics are ours, and ought to be followed by a note of astonishment. Of course Mr. Step means 'a temperature' to be read for the word 'heat.' But that he is densely ignorant of the difference between heat and temperature let the very next sentence bear witness: 'The quantity or degree required varies with,' etc. Here we have the completest proof that the writer does not know the difference between quantity of heat and degree of temperature. Again a like proof is forthcoming on p 151 (the foregoing was culled from the prolific page 32): lichens, we are told 'can endure a greater amount of cold than any other plants.' One would have thought that the presumption of a man pretending to teach science, when he can seriously write of 'a greater amount of cold,' would have been evident to that stereotyped observer, 'the meanest capacity,' if we did not see that it is not evident to Mr. Step.

Frankly, we are weary of exposing the incompetence of this author Patience fails us, and we can only very hurriedly, in conclusion, mention a few cases in which the botanical blunders are more than careless—they are inexcusable.

A cell is, with Mr. Step, only the wall, not the protoplasm included by the wall. He talks quite gravely of 'true species,' as if such entities existed. And he has impertinence enough to laugh at the hypothesis of Schwendener as to the nature of lichens. The reader will scarcely credit this after the criticisms that we have been forced to make. Nevertheless, incredible as it may appear, this amateur dares to talk of Schwendener's hypothesis that lichens are fungi Parasitic on Algæ as 'a humorous theory' (p. 149) that has 'met with the ridicule it deserved.' This is the theory of which Sachs, the foremost of German botanists, in the translation of his second edition by Vines, one of the foremost of English botanists, speaks (without adverse criticism on the part of Vines) thus: 'The admirable labours of Schwendener have shown that lichens, hitherto considered as a separate class, must not

only be included among Fungi, but must be regarded as a section of a particular order of Fungi.' This is the theory Bornet has, by actual experiment, corroborated. A man who has been favourably criticised, or, indeed, has had his views endorsed by three such men as Bornet, Sachs, and Vines, can afford to smile at the ridicule of a Step. Perhaps, after all, the latter is indulging in the Lambeth Field Club vein.

The book is prettily enough printed and published. Only one thing is more marvellous than the temerity of publishing a work so full of errors—that is, that the ignorance of the writer did not prompt him to silence.

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Longmans' Magazine. London: Longmans and Co.

This monthly continues to merit a large share of public patronage. The Christmas number is now before us; its contents are varied, interesting, and attractive. Though some of the contributions are hardly in keeping with this festive season, an excellent shilling's worth of literature is provided. A skit on the Psychological Society by F. Blind, 'Two Robbers,' by the author of 'Reata,' and Wilkie Collins' 'Royal Love' are alike excellent. The illustrations, which are printed in colours, have been done by some of the most popular artists of the day, among whom are Du Maurier, J. Pettie, Marcus Stone, Walter Crane, and Birket Foster.

Cornhill Magazine. London: Smith, Elder and Co.

The most attractive feature of the November issue of this popular magazine is, without doubt, the vigorous and graphic sketch, entitled, 'A Female Nihilist,' by Stepniak. This article alone ought to command an extensive sale for *Cornhill*. It is not often one has the chance of reading so vivid and life-like a story, even in the realm of fiction. Mr. Payn, the editor, and other favourites also contribute to this number.

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